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ELECTRIC TRACTION UNDER STEAM RAILWAY CONDITIONS.

THE above is at once the title of an article in the *Engineering Magazine* by C. H. Davis, and the crude statement of what many electrical engineers believe to be quite practicable, and some believe to be already accomplished. Certainly in the United States where steam worked railways have many features of dirt and danger not known here, the electric locomotive is having a good time of it, and displacing the steam locomotive on many branch lines, especially on the Pennsylvania system, while now it is being specially considered whether the suburban traffic of Chicago cannot be carried on by electric means. One considers that electricity will prove the cheaper power where trains are many, light, and frequent, and of short distance runs, but for heavy work and long journeys steam will show lower first cost and operating expenses, and prove more desirable. We cannot see how, in the present state of the art, any other conclusion more favourable to electricity could be arrived at.

There are two main divisions of the subject, viz., new roads to be built, and old roads to be converted. The first case is, of course, the simpler, as there is no previous capital expenditure to be considered as in the second case, where much material standing to capital account has to be scrapped for ever.

It is considered, and this is very different from the conclusions drawn by Mr. Baxter, to which we allowed considerable space some months ago, that electricity is to-day too costly, both in first cost and operation, except for suburban and inter-urban traffic of short mileage only. We presume if in America the Oldham, Bury and Rochdale steam tramway would be electrically worked. Even on suburban traffic the local freight traffic would be steam worked. The range of electric traction is thus cut down to a radius of about 20 miles as a limit, but in the suburban area it certainly is worth trying. The fixed charges form so important a part of the cost of supplying transportation, that first cost should be of lowest possible amount, and traffic should be a maximum. On steam railways the average percentage ratios are thus given:—

Operating expenses...	65
Net receipts...	35
Fixed charges	25
Profit	10

We are promised proof that the first cost for an electric line will almost always exceed that for steam, a decided disadvantage, because this first cost determines the very serious

item of fixed charges. The inducement to use electricity will have to come from the increased travel to be derived from its use. This increase is now a proved fact. Electricity, in fact, may justify its first cost by the increase of the gross receipts which will pay for the extra heavy first cost. This turns simply on the question of passengers.

The ideal line to the passenger is the one which picks him up at his own door and sets him down at his destination. The steam railroads never approach this ideal. The passenger has to go to given points to be picked up, and thousands by whose door the line may actually run at a few feet distant have a mile to walk in order to board these very trains. By adopting the "leave at your door" plan of the present tramways on part of the system and adhering to the steam road plan on other parts, the ideal might be approached. Comparing the railroads of New England with the tramways, it would seem that with about one-seventh the mileage, the electric tramways carry 33 per cent. more passengers than the steam railroads. About nine times the number of passengers per mile of line is carried by the electric lines. To approach these figures should be the aim of the steam roads, and if they can do so it will pay them to go to some cost for electrical equipment, and a door to door service or its equivalent.

Electric traction will be possible, then, where units are so light and frequent, and journeys short, as with the street tramways, that steam locomotives cannot be had at a lower first cost or operation. It will be possible again where the change will raise the gross receipts, as on the inter-urban lines of closely contiguous towns. It will be possible where competition of parallel electric lines makes the change necessary in order to save what traffic there is irrespective of the question of profits, and it will again be possible and profitable to adopt electric traction where speeds must be higher than those attained by steam locomotives. This last claim is one of those pleasantries in which electrical engineers are apt to indulge to the amusement of steam engine men as though there were in actual existence railroads operated electrically at higher speeds than those regularly attained by steam locomotives. In dealing with an illustration of what the author would propose, he takes a suburban line out of Philadelphia, but the illustration has no value for us, as the scheme presented involves the customary American methods of working railways in the streets, such as cannot be done here. The principal idea seems to be a main line with few stops, and parallel lines with frequent stops, to convey passengers to the few stopping places of the main track. The conclusion of this first instalment of the series of articles proposed is, that for electricity to pay, present steam railway methods must be radically changed. There is no prospect of success in the simple substitution of motive powers. The success must come in with the further possibilities which may be secured if electricity is properly exploited.

Electrolytic Methods of Separating and Depositing Metals.

In the course of a Cantor lecture delivered by Prof. John M. Thomson before the Society of Arts, and published in a recent issue of the *Journal* of the Society, the subject of electrolysis receives some attention. This was only natural, in as much as the lecture dealt with the chemistry of certain metals and their compounds used in building, and the changes produced on them by air, moisture, and noxious gases. Referring to the electrolytic methods by which metals may be separated from their compounds, Prof. Thomson observed that they naturally divide themselves into two classes:—(A) When the electric current decomposes a compound of the metal in a state of fusion, great heat being developed; and (B) when it is deposited upon an electrode, its compound or salt being in a state of solution. Numerous methods have from time been introduced for the production of metals by this method, but it is only since recent advances have been made in the electric furnace that these methods have gone beyond the limit of experimental processes. The method has, however, been employed in the extraction or purification of copper, lead, gold, and aluminium, and, in the case of the last named, bids fair to be the best method for its production when water-power is available and cheap. When an electric current is passed through an aqueous solution of an aluminium salt, no decomposition yielding the metal takes place, and it is therefore necessary to employ fuse salts, generally cryolite, the double fluoride of aluminium and sodium ($Al_2 F_6 6 Na F$). Alumina ($Al_2 O_3$) itself is added to the fused cryolite from time to time, being dissolved and undergoing decomposition, thus avoiding the expense of a bath of pure haloid salt, which would require constant renewal. The second general method for the electrolytic deposition of metals is found in the electrolysis of their various metallic solutions, and is one of very limited application. All metallic solutions are capable of a certain amount of decomposition by electrolysis, such decomposition varying according to the nature of the metal, strength of current, and nature of the electrodes employed. Even mixtures of metallic salts may deposit, when electrolysed, the mixed metals in varying proportions, but the circumstances under which these reactions take place are still more complicated than the deposition from solutions of simple metallic salts. In practice the electrolytic method for obtaining the metal from a solution of one of its salts in some solvent has been mainly used for the purification of copper, which leads itself more particularly to this method of decomposition. The method is, however, employed on the small scale to obtain metals in a high state of purity. Closely allied to the decomposition of a metallic salt by a current of electricity, is the behaviour of one metal to another when the former is brought in its elementary condition in contact with a salt of the latter. In many cases the simple salt undergoes decomposition, the metal contained in it being deposited on the metal which has been introduced. This action depends upon the decreasing electro-positiveness, as it is called, of one metal to another, and attempts have been made to classify metals according to their power in this direction. Such an action of one metal with the solution of another may be seen in the decomposition of a salt of copper by a slip of iron or zinc, or the decomposition of a mercury salt by a slip of metallic copper. In these cases the copper and the mercury are more electro-positive than the metals on which they are deposited. The consideration of the electrolytic deposition of metals from solutions of their salts naturally led to the consideration of what may be termed the wet methods for the isolation of metals. These methods are very various, and occupy the border line between chemical and purely metallurgical processes. They consist of the solution of the various metals in acid or alkaline solutions; the roasting of the ore so as to form a soluble salt of the required metal; the formation of a soluble body by treatment with various gases; and the precipitation of the metal itself, either in a pure form or as some compound which readily undergoes reduction. The lecturer illustrated his observations with experiments.

ELECTRICITY IN COAL MINING.*

By HARRY N. GARDNER.

A good example of the economical results of applying electricity to mining purposes is to be found in the anthracite mines of the New York and Scranton Coal Company, located at Pockville, Pa., about eight miles from the city of Scranton.

The two mines of this company, the Ontario and Sturges, are located well up on the mountain side above the town. They are about three-quarters of a mile apart, the Ontario being what is termed a "slope" or tunnel mine, while the Sturges is entered by a shaft about 200 feet in depth. There is but one breaker located some distance below the entrance to the Ontario.

A double inclined cable road is used to lower the coal from the Ontario mine to the head of the breaker, a loaded trip of cars in its descent always pulling back a trip of "empties" upon the other track. Two donkey engines are used in the transportation of coal from the Sturges shaft to the breaker, and to handle the culm upon the dump.

Two electrical plants assist in the operation of these mines. The generating machinery for the Sturges mine is in the building at the head of the shaft which contains the engines and drums for operating the shaft carriages. One building is also used near the entrance to the Ontario mine to contain the electrical generating machinery and the engines and cable drum for the gravity cable way. Thus one engineer at each place can look after the entire plant.

For the electrical plant at the Sturges shaft a 60 horse-power Ball & Wood engine is used, The engine is belt-connected to an old type bipolar 40-kilowatt C & C generator, operating at 250 volts.

The No. 0000 cable leads are carried beneath the floor to the skeleton oak switchboard, standing a few feet from the dynamo. The switchboard contains the regular instruments, ampere and voltmeters, a G. E. blow-out circuit breaker, large main switch, rheostat and lamps.

Both sides of the circuit lead from the switchboard and out of the building to the head of the shaft a few feet distant. No. 0000 solid wire is used, and the mains are carried down the side of the shaft upon glass insulators, the wooden bracket supports being fastened to the shaft timbers. A lightning arrester protects the line at its exit from the power house, and another arrester is placed in the mine at the foot of the shaft.

Besides the branch circuit taken off for the power house lights, another branch circuit leads from the switchboard to a smaller switchboard in an adjoining room. In this room is a 4-pole General Electric 7½ horse-power dynamo, which is used to furnish power for the pump line when the large generator is not running. This dynamo is driven from the main shaft that operates the ventilating fan. When the large generator is running, power for the pump line is taken from the main circuit. But it is sometimes unnecessary to run the large dynamo, because it frequently happens that the mines are in operation but three or four days a week. The pump, however, must be kept running; and when the large generator is idle the small one is started and switched on to the pump circuit.

At the foot of the shaft one side of the circuit is attached to the rails, and wherever the locomotive is used in the mine, the rails are bonded with a single bond of No. 0 copper wire.

The No. 0000 feeder runs from the foot of the shaft some distance into the main, being supported at the side of the mine upon wooden brackets and glass insulators. The feeder is tapped into the trolley line at three points, a single pole switch being used to cut in the current at these places. As the three sections of trolley are insulated from each other, it is thus possible to cut out any section if desired for any purpose.

The trolley wire is No. 0 hard drawn copper, and is supported by wooden blocks bolted to the roof of the mine. To fasten these blocks, holes are drilled in the roof, into which the bolts holding them are secured by means of split pipe wedges. The old type of General Electric clamping ears and hangers are used to support the wires and insulate them from the blocks. Instead of being placed overhead midway between the tracks, where it would be in the way of the men and mules, the trolley wire is suspended at one side at a point about 6 inches outside the rail.

As the hangers are attached directly to the blocks upon the roof, and the mine varies from 5 to 8 feet in height, the trolley-pole spring is kept in operation more constantly than upon street railroads. On account of the angle at which the trolley pole stands to the wire, and because of the varying height of the wire, an ordinary trolley wheel attachment could not be kept upon the wire if any speed was maintained. The trolley wheel for mine use is therefore connected to the pole with a swivel attachment. On account of the location of the wire, the trolley pole is, of course, attached to one corner instead of the centre of the locomotive.

The locomotive used is a regular General Electric 6½-ton mine locomotive, driven by two W.P. 30 motors. As these locomotives are only three feet in height, it is possible to operate them in low roof mines where it would be impossible to use mules for haulage without going to the expense of blowing down part of the rock roof for headway.

The locomotive is used only in the main tunnels, mules still being used to draw the cars from the chambers and the main gangway. At present the locomotive runs from the shaft to a point about 4,000 feet distant. At the farther end of the trolley line a grade of three per cent. against the load extends for some distance. Up this it would tax two mules to draw a loaded car. In order that the locomotive may not be overloaded because of the voltage drop at the end of the line, only two loaded cars are handled by it on this grade. This load is increased to 8 or 10 cars upon the more level stretches nearer the foot of the shaft, where the voltage drop is less.

Not only does the locomotive handle from two to three times the load which a team of mules would draw, but it handles it from two to three times as fast. There are no mules to get in the way of one another, nor any conflict of loaded trips going out and "empties" coming in. It is therefore found that one locomotive with two men to operate it, can perform the work of from 10 to 14 mules and the necessary driver boys.

When the locomotive is not in use it is housed in a side chamber near the foot of the shaft. This chamber contains a repair pit, so that the underpart of the motor can be conveniently gotten at.

The wires for the pump circuit run down the shaft the same as the trolley feeders, two No. 6 wires being used for this purpose. From the foot of the shaft the wires are conducted to the point where the pump is now located, about 4,200 feet distant, upon porcelain knobs placed upon the side of the mine near the roof. To fasten these knobs, holes were simply "drilled and plugged" in the mine wall, the knobs being screwed fast to the plugs. If a steam pump were used in such a place the steam piping would be more expensive than the wire, it would require more work to change the location of the pump, and more care would be necessary to attend to its operation.

The mine was not in operation the day when it was recently visited; but Mr. W. M. Price, the efficient electrician for the company, descended the shaft, and gave the writer an underground trolley ride. When the end of the line was reached, there was the 5 horse-power bipolar C and C. motor working away energetically at its pump. There it works day in and day out, the only attention it requires being to start it and an occasional oiling. A 5 by 6-inch vertical triplex pump is used; and the motor and pump are mounted upon a truck so that they can be easily moved from place to place.

At the foot of the shaft, and at important points along the main gangway, incandescent lights are tapped off from the trolley circuit. All the underground lights, as well as those in the power house, are run three in series.

The plant at the Ontario tunnel consists of a 12 by 16-inch McEwen engine, which develops 90 horse-power, belt connected to a General Electric 55 kilowatt four-pole, steel frame generator. Weston volt and amperemeters, Carpenter rheostat, blow-out circuit breaker, and the switches, mounted upon a skeleton switchboard complete the station equipment.

But one lightning arrester is used, that at the exit of the lines from the power house. The same voltage is used as in the Sturges mine.

* New York *Electrical Engineer*.

As the locomotive in this case draws the cars to the tunnel's mouth, it is also used outside of the mine to do the necessary switching. When not in use it is housed in a small building a short distance from the tunnel. The locomotive is similar to one in the other mine, and the same trolley construction is used; but as it enters less than half as far as in the other mine, no feeder wire enters the tunnel.

A drill circuit of No. 6 wire is tapped off from the trolley some distance in the tunnel, and from there it is led through a side chamber to another part of the mine. Two drills are used. Each of these, with their motor, which will develop 3 horse-power for short periods, weighs but 121 pounds. The motors are entirely inclosed; thus the drills will stand the rough handling to which they are subjected in being dragged from one part of the mine to another. Current is taken from the stationary wires to whatever part of a chamber a drill happens to be working in by means of a flexible cable. The motor runs at 1,600 revolutions, and a nine to one reducing gear is used for the drill.

With one of these drills two men can drive a six-foot hole, changing drills in the operation in five minutes; while three or four times that, and much harder labour would be required to drive the same hole by hand.

No better idea of the financial side of these electric plants can be given than to quote from a paper read before the Anthracite Coal Operators' Association in January of this year, by Frederick J. Platt, the engineer who installed these plants.

In one part of his paper he said:

"I will now take up two electric haulage plants at the mines of the New York and Scranton Coal Company, at Peckville, Pa., based on the expenses of the year 1896.

"Sturges shaft plant consists of an engine and dynamo, one 6½ ton locomotive and 4,500 feet of trolley wire. Cost, $6,103. 5 per cent. depreciation per year would amount to $305.15, or for 200 working days, $1.52 per day.

"Cost of operating is as follows:

Motorman	$1.75
Helper	1.25
Electrician	.78
Repairs	1.03
Depreciation	1.52
Oil	.24
Total	$6.57

showing a cost by electric haulage for 250 tons of 2.62 cents per ton.

"By mule power the cost would be:

14 mules at 50 cents	$7.00
7 boys at $1.35	9.45
Total	$16.45

"or a cost for 250 tons of 6.58 cents per ton. Thus showing a saving of 3.96 cents per ton, or for 250 tons, about $9.90 per day. Taking 200 working days in the year, there is a saving of $1,980. The locomotive travels about 32 miles per day and has run about 7,800 miles, with a cost for repairs of 2.7 cents per mile.

"This company has also an electric haulage plant at its tunnel opening, where the cost is as follows:

Cost of plant	$7,039.00
5 per cent. depreciation	$351.95, or $1.75 per day

Cost of electric haulage:

Motorman	$1.75
Helper	1.25
Electrician	.78
Repairs	.65
5 per cent. depreciation	1.75
Oil	.24
Total	$6.42

Cost of electric haulage for 600 tons, 1.7 cents.

Cost of mule haulage:

12 mules at 50 cents	$6.00
6 boys at $1.35	8.10
Total	$14.10

"Cost of mule haulage for 600 tons, 2.35 cents, or a saving of 1.28 cents per ton.

"Saving on 600 tons, $7.68 per day.

"Saving in year of 200 working days, $1,536."

Of the electric pump in the Sturges mine, he said:—

"Comparing it with a steam pump for the same work, we find that it is saving the cost of two men or boys, who would be required to look after a steam pump, from the fact that the pump is first running on water and then on air, and a steam pump under these conditions would require close watching.

"Had a steam pump been used in this place it would have been necessary to put down a bore hole for the exhaust steam, or use a furnace condenser, as the roof in a return air-way is very poor, and would not permit the exhaust steam being turned into it.

"This pump and the wiring cost $625, which was less than a steam pump with the piping. The repairs during 1896, including wire used in changing its location, amounted to $159.55 for 365 days and nights.

"The cost of operating per day of 24 hours, for the past year, has been as follows:—

Repairs	$0.43
Oil	.10
Electrician	.41
Total	$.94

"Cost of operating a steam pump would have been at least two boys at $1.25—$2.50, without taking into account the oil and repairs. The saving, therefore, has been at least $1.56. It has run for 970 days, which shows a total saving of $1,513.

"The fact that the pump is drawing water through 700 feet of suction pipe is one of the strong points in favour of electric over steam pumps for such work as pumping out dips and slopes which are being driven, as it only becomes necessary to change the location of an electric pump every few months, instead of every few weeks, as would be necessary were a steam pump used."

In speaking of electric drills he referred to one of those in the Ontario mine when he said:—

"The New York and Scranton Coal Company is using one of these drills for driving a heading and airway through a poor piece of coal. The vein averages 7 feet 5 inches in height and contains 46 inches of coal and 43 inches of rock. It is driving this at a cost of $2.85 per yard, as against $5 per yard, hand work. In the month of September it drove 109 yards; 58 yards in the heading and 51 yards in the air-way, which was a decidedly good showing for an electric drill as compared to what could have been done by hand power, both as regards cost and number of feet driven.

"In all of the above figures you are probably aware that no charge has been made for steam used by the generating plant. This is due to the fact that in none of the above mentioned cases has it been necessary to add to the boiler plant, and the fuel used practically costs the company nothing."

In regard to the economy of electric haulage in coal mining, the superintendent of the Hillside Coal and Iron Company, which at Forest City, Pa., operate the largest electric mining plant in the United States, recently said that he had kept an account of the cost of operating one part of a certain mine with mules and another part of the same mine with an electric locomotive. He had figured his mules as costing only 25 cents a day each; but he admitted that he had given the mules the benefit of every doubt.

With mule haulage he found that it cost 5.86 cents per ton, while the electric locomotive did the work for 5.04 cents a ton. "This looks like a rather small saving, only ·82 of a cent a ton, or only 14 per cent. in the cost of haulage," said the superintendent, "but it is only fair to explain that the electric locomotive worked in a part of the mine where mules could not be used on account of the steepness of the grade against the load, while the slight grade in the part of the mine operated by mules, is in favour of the load."

Appointment.—Mr. W. G. Toop Goodman has been appointed assistant electrical engineer in the tramway construction branch under the New South Wales Government, at a salary of £300 per annum.

SWANSEA CORPORATION TRAMWAYS BILL.

The Committee sat again to consider the Bill on Thursday last week.

Mr. Watkins (the Mayor), in re-examination, said that the question had been before the ratepayers, and the municipal election turned upon it, and beyond that every facility was given to the property owners to vote when the poll was taken. He did not contend that the tramways had hitherto been a success, and that he attributed to the present system of traction, and to the want of a proper service.

Mr. Lloyd: Have you not had your powers to illuminate by electricity for some time, and have not used it?—Yes.

Is it the fact that you desired to see electricity as an illuminant an assured success before you took steps to provide it for Swansea?—Yes, that has been the feeling of the Council and the people.

Now, having seen what has happened in other towns in England and elsewhere, and also having the opportunity of supplying the electricity for tramways, you think the time has arrived when those powers should be exercised?—Yes; I think we shall have great advantages.

Lord Kelvin, replying to Mr. Freeman, Q.C. (counsel for the Bill), said he had visited Swansea, and had gone over the line of the proposed new tramways, and he had seen the tramways at present laid in Swansea. He had also visited the site for the proposed central electric station. He was of opinion that the powers proposed to be taken by the Corporation would be for the public benefit. He had carefully examined the proposals made by the consulting engineer, Mr. Manville. His opinion was that if the tramway company took from 600,000 to 700,000 units per annum, the electric energy could be supplied to the central station during 16 hours out of 24 at less than 1d. per unit, which was a remarkably cheap price. He was aware that Mr. Manville had suggested two methods by which the electric supply could be given, and he believed that the object could be attained by either of the methods; but inasmuch as it was proposed to light at a considerable distance from the central station, he would prefer the alternate current high pressure system. It was proposed to light at a distance of 3½ miles, and to light at a distance the alternate current and transformer system had been most generally adopted, and practical experience had shown that it would be perfectly safe to undertake that system for Swansea. He considered the site for the central station an exceptionally good site. There were few towns that could allow of such a good site for a central plant. It was near the dock, where coal could be unshipped at a very low cost, and there was a good strong foundation suitable for the erection of engines, boilers, chimneys, &c. He was aware that it was proposed to place a destructor in the neighbourhood of the generating station, and he was convinced that it would be an important factor in reducing the amount of coal to be used in the electric supply. At the same time he did not take that into account in reference to the answer he gave to supply the tramway with electric energy, and he believed the estimate laid before the Corporation assumed that no assistance would be derived from the destructor. He himself believed that the destructor would save considerable coal, but in any case it would be an economy, because refuse must be got rid of somehow. He was aware of the terms upon which the Corporation proposed to supply electricity to the tramway company, and in his opinion it would be an economical and wise thing, and for the public benefit. It was the fact that electrical engineers attached great importance to getting a customer in the day, and the hours at which they would supply electricity to the tramway company would not conflict with the hours at which they would supply the current for illuminating purposes.

Taking all these matters together, and taking the scheme as a whole, you consider it a wise and proper one for a public authority to undertake?—I do.

Cross-examined by Mr. Boyle: He did not know what the cost of the site would be. The cost of providing electric energy to the tramway company would be very small compared with the whole of the amount of the expense of buildings and engines which would be defrayed by the demand for the electric light at the higher rate. He thought there would be a large demand in the town of Swansea for the light.

You will agree with me all depends on the cost of the generating station, the cost of buildings, and the cost of machinery, as to whether it could or could not be supplied at 1d.?—As to whether the whole undertaking will be successful, it depends on the cost of the site, &c., the way it is worked, and the quantity taken.

Further examined: He knew Swansea fairly well. He had been up as far as Morriston, and thought the tramway would be much used. He did not think the streets were too narrow for tramways. There was one considerable gradient.

By Mr. Statham: He had not been associated with an application for electric powers in any other town for such a wholesale system as that. It was his first experience of advising a corporation with respect to supplying current for both lighting and tramways. He believed that the transformation from high alternate to low pressure continuous would not give more than 15 per cent. loss.

In what particular instance is that generalisation of yours formed?—I believe in Portsmouth it is successfully done for the arc lighting. Rome is the greatest instance, and it has been very successful.

They have water-power there?—I believe so.

Take Portsmouth, the cost per unit actually sold is 2·06, according to the Board of Trade returns?—The cost of coal is high.

Continuing, Witness said his estimate of 1d. was for the cost of the supply for 16 hours out of 24, but, of course, it was obvious that during some portion of the 24 hours the current would have to be supplied to both the lighting and the trams. To say that the loss on transformation would be between 30 and 40 per cent. was enormously over estimating the loss. He had not taken gradients and other matters in connection with the line into his consideration, for the Bill was for the delivery of electricity to the central station, and it would be taken to the tramway company for them to do what they liked with it. He took the estimate of 400,000 Board of Trade units at 2d. for tramway purposes, and the Corporation estimated 363,000 Board of Trade units for illuminating purposes at 6d. per unit. He had no doubt but that the Corporation would reduce the price below 6d.

Assuming now that there has been by inadvertance some false calculation that would very much shake the strength of your statement of being able to reduce it to 1d.?—It would not shake my opinion as to the extra cost involved. I believe if the town only takes 200,000 units, it will still be a paying concern.

What would determine the rise or fall in the extra price of generation?—The fact of the cost to the tramway company would not be affected by the other part.

What I want to get at is the basis upon which you calculate your 1d. in this particular instance. I will take it you have a splendid plant, but would your future cost of generation fluctuate with the consumption for illuminating purposes?—I find coal costs 1·7d. every Board of Trade unit to supply the proper voltage at the central station.

Then does it make any difference to your mind the possibility of there being no real substantial consumption during day time. Would it make any difference in your opinion as to the final total cost of the generation of electricity for all purposes?—No.

By Mr. W. D. Benson: He could not conceive any corporation doing the thing unless it was for the interest of the town. He could not speak for the tradesmen, who might not be able to have carts against their doors in consequence of the narrowness of the streets.

By Mr. L. M. Richards: The estimates of Mr. Manville and Mr. Preece were laid before him, but he made his own estimate. He knew the tramway crossed the bridge, and that the bridge was opened to let vessels pass, and all vehicles must stop when the bridge was up. It would be little waste of energy for the tramways to have to stop while the bridge was up. There was a question of the Bristol Corporation wishing to supply the tramways at that city with generating power, and he was called in to advise the tramway company. In that instance he advised the tramway company to continue to supply their own energy, but it was a different case for Swansea, where both the lighting and tramway would commence at once.

You have never advised before, and you think this is an experiment which will work very well?—We have the experience of success of the same system as in Rome. A description of that is in the Electrical Review of May 7th.

You think it would be a financial success?—Yes.

And you base your opinion on supplying the light at 6d. per unit?—Yes; but I think in a year or two the Corporation will supply it at less.

Are you aware that Mr. Marten said that they will supply it at 3d.?—I am very glad to hear it.

And you think it would be successful?—You see companies paying 7 and 10 and 15 per cent. and supplying it at 4d.

Proceeding, Witness said that the favourable circumstance of Swansea, besides coal, were the years of electrical experience and the improved machinery. Everyone knew the large dividends being paid by companies on large capitals, and corporations borrowing money at 3 per cent., ought to be able to make it pay at 3d. per unit. He could give no single instance of a corporation supplying electricity at 2d. per unit.

Mr. Albert Mason, formerly Mayor of Swansea, and a large carrier and railway agent, expressed the opinion that the change from horse traction to electric traction would be an improvement from several points of view.

Mr. J. E. Waller, M.I.C.E., who jointly prepared the plans for the Bill, gave evidence in support of the scheme. He did not see any objection to electrical traction being used on the roads of Swansea. In his opinion electric traction was much safer than horse traction, especially where the cars had to run through narrow streets. As an example of the view which the Board of Trade took on the subject of electric traction, he said that they had granted a provisional order for electric tramways for York, although one portion of the line, 750 feet in length, varied from 15 feet 11 inches to 28 feet 10 inches. Mechanical traction in the form of horse-power had hitherto not been allowed on the line, but the restriction had been withdrawn in favour of electricity. There were also tramways in South Staffordshire worked by electricity, where there was a length of 196 feet, single line, laid in a road only 18 feet wide between the curbs.

Mr. Manville, electrical engineer, said that he had been concerned with his partners in several electrical tramway undertakings. In 1894 he was engaged by the Swansea Corporation to advise them as to their electrical lighting undertaking, and also the question of a dust destructor. He placed two schemes before them, one a low tension continuous system, and the second the high tension alternate scheme. The first scheme would have been slightly cheaper to instal and maintain, but he told the Corporation that if they wanted to supply current to the further end of the borough, it could be done more economically in the end by the high tension system. A committee was appointed, and members of that committee, with him and without him, visited several dust destructors, and they recommended the Council to adopt his report, and he was instructed to prepare a scheme on the high tension system, and he had prepared the details of such a scheme. When preparing the details he was consulted as to equipping the tramway with electricity, and was asked to state what would be a suitable price to charge. In 1895 he placed before the committee a statement showing the price at which they could afford to supply current to the tramway company. He went into it very carefully, and estimated a price which would not be prohibitive to the tramway company, and which would be no loss to the Corporation. In estimating, he considered that the company would be

consumers for 14 or 16 hours a day. It was an axiom amongst electrical engineers that the cost of production depended on the number of hours they could work the power. He advised that they could supply the company with a minimum supply of 600,000 units at 1½d. per Board of Trade unit. He advised them to instal three generators with a large battery of accumulators. The reason of the advice to supply a large battery of accumulators was to supply the tramway system with current during the time the current would also be required for illuminating purposes. He did not estimate for any power to be obtained from the destructor, so that would lessen the cost. The fact of having a battery of accumulators had another advantage, as it would cause a steady pressure to be maintained on the lighting mains when only one engine was running. The system was well known out of England, and in Hamburg the trams were supplied at a cost slightly under 1d. per unit.

By Mr. STATHAM: He agreed with Lord Kelvin that it was possible to sell profitably at 1d., and the return for Portsmouth, which would be published that week, showed the cost to be 1·7d.

The Committee adjourned till Friday.

The Committee resumed its sitting on Friday, when Mr. MANVILLE continued his evidence, and was cross-examined at some length regarding his estimates, which he maintained had been made on an accurate basis.

In re-examination, the WITNESS said there was no town in England where electric power was supplied by a corporation to tramways and for lighting purposes. Since Swansea had promulgated its scheme, various towns had sought to follow the example. He was quite satisfied that the Corporation would be able to supply the current to the tramway company at the price estimated, and that they would make a good profit out of it, which would go towards reducing the cost of the light to private consumers. Swansea would, therefore, be in a very advantageous position, inasmuch as it would be able to start clear off with a customer that would relieve them of the day load.

Mr. W. H. PREECE, C.B., F.R.S., postal electrician to the Government, replying to Mr. LLOYD, said that he was called in by the Corporation of Swansea to report upon the scheme which had been prepared by Mr. Manville. He was familiar with the principle upon which Swansea was desirous of acting in regard to their triple scheme—the electric lighting, the dust destructor, and the tramways. He had viewed the question from all points of view, and had formed a favourable impression of the scheme. The fact that there was not a second similar proposal in any town in the country was an important factor to be considered in the present case. He quite agreed that the cost of the production of electricity was reduced as the load was spread over a larger number of hours. He felt confident that the proposals of the Corporation would benefit the population of Swansea, and that in all human probability it would be a financial success. He had inspected the arrangements for the supply of current to the tramway system in Rome, which in most respects was analogous in system to that proposed at Swansea, and he was able to testify from his personal observations as to the efficiency and excellence of the arrangements there.

In cross-examination, WITNESS said he believed that if Swansea got its triple scheme, they would be able to supply current at 3d. per unit. He did not suggest that at present the working population of Swansea would use electric light—it would be taken by shops, hotels, public houses, the better class of private residences, &c.

Prof. SILVANUS THOMPSON next gave evidence on behalf of the promoters. He was, he said, consulting electrical engineer to several important companies, having been called in to advise the City of London Electric Lighting Company, the Reading Electric Lighting Company, the County of London Electric Lighting Company, the Brush Electric Engineering Company, and others. He had also given much attention to electric traction, and had a good general knowledge of electric traction methods. He had read the report of Mr. Edward Manville on the electric lighting at Swansea, and also his report on the tramway scheme. He was acquainted with Swansea, and had considered the local conditions in relation to the proposed schemes, and particularly to that feature of the scheme which dealt with the supply of current to the proposed tramway. The scheme in which it was proposed to supply the town with a high pressure distribution using steam power, to be partly supplied by means of a dust destructor, appeared to him to be a suitable one for the locality, and from the experience of other lighting stations, and in particular of other municipal electric supply undertakings in which a high pressure supply was given, it was clear to him that after the system should have got to work, the actual cost per unit of producing an additional 600,000 units per annum would not exceed 1½d., but would in all probability fall below that figure. It was an immense advantage to an undertaking such as that proposed that it should have to provide current for an all day purpose, in addition to the very variable demand for lighting, which was excessive for an hour or two, and almost *nil* during many hours out of the 24. Hence he regarded the agreement arrived at with the tramway company as one entirely satisfactory from the point of view of the undertaking as a whole. The adoption of a sufficient battery of accumulators to supply the tramway during the four hours of heaviest lighting load, would equalise the operations at the station, and tend both to economy of labour, and to regularity in the working of the plant. The revolving transformers to be used for the transformation of the high pressure currents to supply the tramway system at the lower pressure of 500 volts would be a necessary feature of the distribution under any system. As the tramway would work under Board of Trade rules with an earth return, and as the lighting would work under Board of Trade rules which forbade an earth return in that circuit, revolving transformers became an absolute necessity to isolate the one part of the system from the other. Revolving transformers were a form of apparatus now well known. There was nothing new or untried about them. They had been in use for years in the supply systems of many towns, as for example, Oxford, Cassel, Pontresina, while other examples existed in the Dublin Tramway Supply, in the Crystal Palace District Supply, and in the system used for supplying current at a low pressure for aluminium production from the high pressure distribution at Niagara. They were made by many, if not all, of the best firms of constructors, and could be guaranteed to have efficiencies of 85 to 90 per cent. There was no difficulty in the use of such apparatus either for the purpose of supplying an electric tramway or for that of charging accumulators; such difficulties as presented themselves when that kind of machinery was first proposed some years ago having been entirely solved. Any opposition to the use of such apparatus could only arise from want of information as to what had been done, and what could be done, by its employment.

Mr. ARTHUR WRIGHT, manager to the Brighton Corporation Electric Supply, gave evidence in support of the scheme, and gave it as his opinion that it would be a profitable one for the Swansea Corporation, especially in view of the fact that they would be able to get rid of their day load to the tramway. The price at which it was proposed to supply the current to the tramway company would, he believed, be remunerative to the Corporation.

Mr. GEORGE HOPKINS, C.E., who has had considerable experience in tramway construction, next gave evidence in favour of the Bill. He stated that he had inspected the tramways at Swansea. A most important feature of the Bill was that which authorised the working of the tramways by electrical or other mechanical power approved by the Board of Trade, and by the lease the Corporation agreed to supply the electrical energy required for working the tramways, receiving from the tramway company for that a minimum sum of £3,333 6s. 8d. per annum. That would be a great benefit to the Corporation, and aid them materially in supplying electric lighting to the borough, as the greater part of the energy required would, of course, be taken in the day time, and thereby lessen the expenses of electric lighting. From the published reports of the tramway company, it appeared that their working expenses were about 8d. per mile, and their receipts about 9½d. On electrically equipped tramways the working expenses would probably be not more than 4d. per mile run, and the receipts would be considerably more than 9½d., and with good management, cheaper fares, better service, and increased receipts, the company should be able not only to meet their engagements to the Corporation, but pay moderate dividends to the shareholders. In his opinion the agreement and proposed lease were sufficiently favourable to the Corporation to justify them in entering into the proposed arrangement, and they were well advised in electrically equipping the lines. He also thought that the Corporation would be well able to supply electrical energy to the company on the terms agreed.

Mr. W. H. P. JENKINS, agent of the Earl of Jersey, Sir ROBERT ARMINE MORRIS, a local landowner, Mr. H. GLYN PRICE, and Mr. GEORGE BELL, C.E., borough surveyor of Swansea, all gave evidence in support of the Bill. Mr. Bell said that some of the gradients of the tramways were quite unsuitable for horse traction, involving cruelty to the animals, which, of course, would be obviated if electricity were adopted as the motive power. From what he had seen in other places—Walsall, Wednesbury, Bristol, Coventry, &c., he was of opinion that electrical traction would tend to greatly increase the tramway traffic. He did not consider that there would be any objectionable features about the overhead wire system; it had not been found objectionable in other places. He should say that the generating station was in as good a site as could possibly be found for it.

The Committee adjourned until Monday.

The Committee resumed its inquiry on Monday. At the commencement of the proceedings counsel, on behalf of Lord Kelvin, asked that his answer with reference to the dividends paid by electric lighting companies should be amended. In his examination Lord Kelvin said that these companies paid dividends varying from 8, 10, to 15 per cent., and he now wished to alter that answer to 8 and 12 per cent.

The CHAIRMAN allowed the correction to be made in the official minutes.

Mr. BELL, the borough surveyor, was recalled. In cross-examination he said he had never heard of any pressure being brought to bear upon the Corporation to undertake the electric lighting of Swansea.

Mr. HOPTON, the borough accountant, gave evidence relating to the financial position of the borough.

Mr. W. THOMAS, assistant overseer of Swansea, was examined relative to the polling of the town on the triple scheme, which resulted in 5,521 votes being recorded in favour, and 4,635 against.

Earl JERSEY stated that he was a landowner at Port Tenant, where it was intended to extend the tramways, and that would be a benefit.

Mr. RICHARD MARTIN said that he had been a member of the Town Council for some years, and was chairman of the Electric Light Committee. After much consideration they had obtained a provisional order, and Mr. Manville had drawn up a scheme. In his view the site selected for the generating station, and the dust destructor was the best that could be obtained. In his view it was necessary to run the tramcars by other power than horses if they were to be made a success, and he thought electricity was the best power. Owing to the gradients of some of the streets it was necessary to have electric power, for the cars were too heavy for horses. He was decidedly of opinion that the scheme accepted would be a success.

The Committee resumed its inquiry on Tuesday, when Mr. BALFOUR BROWNE, representing the Gas Company, addressed their Lordships in opposition to the Bill, contending that the people of Swansea had

been misled into voting for the scheme, which he described as entirely speculative. He submitted that no evidence had been called in proof that the triple scheme would be a remunerative one to the ratepayers, and he asked their Lordships to say upon the evidence of the promoters that the scheme was a ruinously speculative one into which the Corporation should not be allowed to embark.

The Chairman intimated that the Committee desired Counsel to confine their evidence in the first instance as to the way in which the poll was taken and as to the feeling of the ratepayers in opposition to the Bill. A large amount of evidence was given upon this point, and in the result the Chairman said the Committee had decided that the preamble of the Bill had not been proved.

THE INSTITUTION OF CIVIL ENGINEERS.

A Conference of the members of this Institution was commenced on Tuesday at the Westminster Town Hall. After an opening address by Mr. Wolfe Barry, the President, the Conference divided into various sections for the discussion of different subjects. The aim and objects of the Conference may be seen from the following extract from the President's address:—

"The Institution can now be truly described as a body which is representative of every walk of our many-sided profession in every part of the globe. Thus its ramifications extend not only to every city and town of the United Kingdom, but its members and representatives are to be found in every country to which British enterprise has extended. From the small beginning of 1818—which had not attained to a growth of 200 members of all classes in 1828, who, from the difficulties of intercommunication between different parts of these Islands, must have been mainly, if not exclusively, Londoners—we have increased by leaps and bounds so that we now number 6,200 members, associate members, and associates, and 900 students, making a total roll of 7,100. It is not too much to say that in this past sixty years, a new and most important profession has arisen, second to none in its responsibilities and in its value to humanity at large. A little more than 5,000 of our members are in the United Kingdom and 2,000 are abroad; and as almost all the students and most of the associates are to be found at home, we may probably say that, of our corporate members now carrying on their profession, from one-half to one-third are in our colonies or dependencies or in foreign countries. Of the 5,000 members, associate members, associates, and students in the United Kingdom, 1,950 of all classes are living or practising in the metropolis. In many of the great towns of the kingdom we have important local Associations directly connected with the Institution, through well-intended and highly-successful efforts to benefit the students of our professions. The number of members and associate members in the various local Associations is as follows:—Birmingham and the neighbourhood, about 200; Glasgow, 150; Manchester, 200; Newcastle-on-Tyne, 120; Leeds, 150. Without this mutual inter-dependence, the Institution would be but a poor representative of our profession; and it should be the aim of us all to strengthen and increase the bonds which now unite us in the knitting and development of which so many past presidents and councils have taken the greatest interest. It is with the view of further strengthening the bonds of union that the Congress of this year has been instituted; and I venture to hope, not only that it will have the results which we all have so much at heart, but that it may be the precursor of many more annual gatherings of a similar nature. Apart from visits, our desire has been to encourage, by means of short papers read at the meetings of the sections, an interchange of ideas and the imparting of the most recent information on all the multifarious subjects which together are included in the expression civil engineering."

"THE TRANSMISSION OF POWER BY ELECTRICITY."

By William Henry Preece, C.B., F.R.S., Vice-President Inst.C.E.

The utilisation of the waste energies of nature is the highest function of the engineer. Millions upon millions of units of energy are ever being expended on rending rocks, on grinding stones, on changing river beds, and on carving the surface of the earth into hills and valleys. Their transport to centres of civilisation means not only the permanence of the structure of the face of nature, but the exercise of true economy.

The relative merits of the different modes of transmitting power can be determined commercially solely by the arbitrement of £ s. d., and scientifically by their relative efficiencies; that is, by the ratio in each case of the power utilised at a distance to the total power delivered at the source.

Long Distances.

Supposing we have available at some convenient spot, at all hours and seasons, 100,000 gallons of water falling every minute 45 feet, they will be capable of delivering 1,000 kilowatts (1,340 H.P.). If this power is transmitted to some distant point by electricity there will be wasted:—

	Kilowatts.
In the turbine	250
„ dynamo	60
„ circuit	15
„ motor	50
Total	375

So that of the 1,000 kilowatts delivered by the water, 375 kilowatts are wasted and 625 kilowatts are utilised at the final point of application. The total efficiency is, therefore, 62·5 per cent.

It is quite clear that the energy wasted in the circuit is to be eliminated only by taking materials to the fall and establishing factories there. But the transport of material may cost more than the waste in the circuit. Hence we have to compare the cost of transport against the cost of the up-keep of the line and the value of the energy wasted in it.

There are three effective modes of transmitting power—electricity, water, and air. What we have broadly to discuss is their relative efficiency. How much of the total energy available at the initial or generating point can be delivered at the final or useful point? In other words, how much have we lost in transit and conversion? What price can we get for our commodity as delivered, and what profit do we make on the transaction? Each method of transmission is limited by the strength of materials, the loss of energy, the heat generated and physical difficulties overcome, the dangers to person and property, the capital expenditure and cost of transmission and delivery.

Now, it is the peculiarity and value of electricity as the medium of transmission that the energy wasted on the line can be kept a constant quantity independent of its length, but the cost of up-keep must, of course, increase with its length. Hence the principal item we have to consider is the up-keep of the line and the capital that has to be expended on its erection.

A main of copper of 1 square inch sectional area carrying 1,000 amperes would waste in heating up the conductor 1 kilowatt (or 1⅓ H.P.) in every 40 yards. If it carry 500 amperes, it would waste the same energy in every 80 yards; and if only 50 amperes be used, in every 800 yards. Hence the value of reducing the strength of the current. This is entirely under our control, for the weight of copper in the mains for the transmission of the same power with the same loss varies inversely as the square of the pressure. 1,000 volts will deliver 1,340 H.P. (1,000 kilowatts) through a square inch main at a distance of 5·6 miles, but with a loss of 50 per cent. of the energy generated. 10,000 volts will deliver the same power at a distance of 27·5 miles, and 20,000 volts will deliver it at 110 miles with a loss of only 2·5 per cent. At shorter distances the waste can be reduced still further. The pressure applied, as in water, is limited by the strength of materials, and by the stresses brought to bear upon them. It is difficult at present to insulate more than 20,000 volts. Indeed, the maximum pressure used in England and Germany is 10,000 volts, while 6,000 volts is the apparent maximum in the United States of America. Were it practical to use higher pressures, it would be possible to deliver power by electricity at distances of about 200 miles from the place of generation so as to compete favourably with steam. But with the present price of coal in this country, and with practical pressures, the radius of economical delivery does not exceed 40 miles.

The same argument applies as much to the actual transmission of the water itself from the fall to the convenient spot where its energy is extracted, as it does to the transmission of the energy in the electrical form from the points of transformation to its delivery at the point where it is applied. The distance to which it is practical and economical to transport energy is thus controlled by the cost of generating energy at the given point of application, and this depends on the price of fuel at that spot. Coal is thus the predominant element.

Egypt is a typical case of the possibilities of the transmission of power by electricity. On the Nile there are at Merawi and Wady Halfa magnificent cataracts where immense quantities of energy are running to waste. Is it not possible to utilise this waste energy in Cairo or its neighbourhood? Certainly it is, but at what price? How will it compare with the cost of fuel from England?

There are many instances of economical and successful utilisation of water-power in the United States and Canada.

The following is a list of a few typical instances:—

Place.	Power-house.		Distance in miles where utilised.
	H.P.	Kilowatts.	
Niagara	20,000	15,000	21
Sacramento	11,000	8,250	24
Ogden	11,000	8,250	36
Big Cottonwood ...	7,000	5,250	14
Concord	5,000	3,750	4
Portland	4,600	3,500	12
Fresno	2,300	1,700	35
Quebec	2,200	1,650	8
San Francisco	1,000	750	12

There is a remarkable example of successful transmission of power in Italy, from Tivoli to Rome, a distance of 18 miles; 50,000 gallons of water per minute falling 160 feet at Tivoli are equivalent to 2,400 H.P.

75 per cent. of this = output of turbine ...	= 1,820 H.P.
90 per cent. of which = output of dynamo	= 1,620 H.P.
18 per cent. of which = loss on line ...	= 292 H.P.
Making delivery at Porta Pia	= 1,328 H.P.
90 per cent. of which is utilised in Rome ...	= 1,196 H.P.

Thus 50 per cent. of the power of the waterfall at Tivoli is used in Rome.

Switzerland teems with successful installations, and there are numerous examples in Germany and in France.

At Foyers, Worcester, Keswick, Windermere, Lynton, electricity is obtained from water-power, but in no case is any great distance covered.

At Worcester the Corporation have established their generating station for lighting the town some 2 miles away on the River Teme, a tributary of the Severn. Here some 250 H.P. is obtained from a 10-foot fall, and the advantages obtained through the reduction in generating costs have fully justified the experiment.

The cost of generating per unit was, last year, under 1½d., although it was necessary to generate 200,000 units out of a total of 333,000 from coal. The net cost of generating the units produced from the falling water was under 0·8d. per unit.

It has been proposed to burn coal at the pit's mouth, and to transport the energy extracted as electric currents to London.

So far as can be seen at present, it is cheaper to transport the coal. The cost of coal does not form the sole charge in producing electricity. Management, labour, repairs, depreciation, and interest on capital expended are much more important items in steam plants.

Assuming that it is required to transmit 1,000 kilowatts, and that the total annual quantity of energy transmitted is 3,000,000 kilowatt-hours—an amount of electrical energy easily produced from 5,000 tons of coal. If the cost of transporting coal 100 miles by railway is 5s. per ton, the annual bill for transport will be £1,250. This represents only 0·1d. per unit produced, and is less than the interest on the capital required to be expended on the construction of the line.

Power in Cities.

In most of the cases mentioned above, it would have been probably impossible to transmit power otherwise than by electricity, but when the transmission of power by electricity is considered in relation to the supply of power to the inhabitants of a town, to railways and to tramways, to various separated portions of machinery, such as in large works, on board ship, in coal and other mines, the rivalry of other methods is encountered.

The advantages claimed for electricity are ease and cheapness of distribution, facility in application to nearly every type of machinery, efficiency in generation and in transformation to power, cleanliness and safety, reliability and convenience for repairs.

As an illustration of the transmission of power in large cities, let me take London as the best example, and assume that it is desired to work both the Metropolitan railways by electricity. Clearly the power house should be on the river bank, for we must be dependent on coal, and we should be where coal is cheapest; but whether the coal be used direct as fuel, or converted into gas first by the Dowson or Mond process is a matter for consideration foreign to this discussion.

Mr. Humphery (March 16th, 1896) estimated that by the use of the Mond gas-producer plant, it was possible, under certain circumstances, to produce a kilowatt-hour for 0·184d., and this could be easily distributed and applied on a coach on the railway for a cost not exceeding 1d. per unit.

For Workshop and Home Use.

The horse-power lost in shafting is little known. Mr. C. H. Benjamin, of Cleveland,* tested 16 different factories of all kinds in that city. He found that from 50 per cent. to 80 per cent. of the H.P. developed was absorbed by the shafting before it reached the machine where it was to be utilised.

For small powers the horse, from the point of convenience, beats everything. But its food corresponds with the "waste" of other systems, and though, if we regard its efficiency in converting fuel into energy it stands perhaps at the head, yet the price of its food, and the waywardness of its health, makes it the least efficient of all machines in a commercial and economic sense. Oil and gas for small powers are more convenient, but not so economical as steam, while electricity, if it can be supplied at 1½d. per kilowatt-hour, is the most convenient and economical, for it is always ready if supplied from a central station. It requires no boiler, and it is accompanied by no danger. It is handy; it is placed where it is wanted, and used when it is wanted. You pay only for that which you have used. It is useful not only for small trades, but it is invaluable for domestic purposes, for sewing machines, ventilation, pumping, cooling, lifting, and for many other purposes. It is, however, but little used in England at present. High prices, ignorance, and fear have kept it in the background; but it is rapidly and successfully coming to the front.

The efficiency of the dynamos which transform energy into electricity, and the efficiency of the electric motor which transforms this electricity into mechanical power, are unequalled. Dynamos and electric motors are now commercially made at moderate prices with efficiencies of from 94 per cent. up to 96 per cent.

Broadly speaking, it may be said that there is no practical difficulty whatever in transmitting energy to great distances by water, oil, coal, gas, air, or electricity.

Their relative merits depend, first, on their relative efficiencies in production and application, but their financial success depends solely on the cost of transport. There are many cases where each must be paramount. There are others where the balance is questionable, and where other conditions, such as space, convenience, cleanliness, safety, silence, must be considered. Electricity, however, bears the palm for long distances.

"THE TRANSMISSION OF POWER BY WATER."

By Edward Bayzand Ellington, M.Inst.C.E.

These notes have reference only to the high pressure system of transmission which is now generally understood when the term "hydraulic power" is used, and it is assumed that fuel is required for its production.

* Vol. xviii. of American Society of Mechanical Engineers. See Electrical Review, December 25th, 1896, p. 847—849.

The most distinctive feature of hydraulic transmission is that a heavy medium is employed, having no elasticity. Velocities must be kept low to avoid shocks, and to prevent excessive loss by fluid friction. These characteristics have an important influence on the economy of the central stations. The main engines are kept running with a constant load, notwithstanding variations in the draught on the mains. The speed alone varies. There are thus present the conditions of a high efficiency, viz., high pressure, low velocities, and constant load.

A hydraulic press is the typical mechanism, and involves the most direct application conceivable of these essential elements. But a simple hydraulic press is not the most perfect application. The motion under full pressure is a small part of the total, and in most presses the efficiency calculated on the work done is low. Maximum efficiency is met with in hydraulic hoists for lifting coal trucks, for here the advantages of non-elasticity and pressure are utilised to their fullest extent, and something like 95 per cent. of the power conveyed is converted into useful work. Such machines are little more than reversals of the accumulators at the central station.

The efficiency figures for hydraulic transmission are:—

Loss at the central station	15 per cent.
„ in transmission, say	5 „
„ in use, say	5 „
Net power utilised	75 „
I.H.P. at central station	100

This efficiency can be realised over an area of, say, 4 square miles served from one station, but as the designs of the machines vary with the purposes to which the power is applied, the 75 per cent. may drop to 25 per cent., or even less, and when further the power is supplied from public mains under a sliding scale of charge, there may be great differences in the actual cost of doing apparently the same amount of work.

In order to compare different methods from a scientific standpoint, the precise conditions require to be accurately defined, and the best that can be practically attained under the special conditions assumed. Though no one system of transmission can be pronounced to be absolutely the best under all circumstances, it is clear that in such cases of transmission as are required for lifting and pressing, the hydraulic method has many marked advantages. No brake is required. Lifting is intermittent work. The full pressure and power at command is immediately applied without loss. Thus economy as well as safety is obtained. There is a loss of power at light loads, but they are lifted at an increased speed. Speed has an important bearing on efficiency, and no data are reliable for purposes of comparison without reference to it. It is unusual to work lifts at less than 100 feet per minute, but speeds of 500 feet to 600 feet per minute are often required. Within such limits the efficiency of the same apparatus may vary greatly. There is also the question of the type of machine. Broadly stated, a hydraulic ram-lift, though the safest and simplest, and the least costly to maintain, has in most cases a low efficiency. The only reason for the adoption of ram-lifts for considerable elevation is their greater safety.

Hydraulic power is admirably adapted for pumping and working many machine tools direct, while hydraulic engines and turbines are available for driving general machinery. Their efficiency is fairly high, and the power can be automatically adjusted to the load. A good deal of care, however, is necessary to prevent waste.

Hydraulic power is a most valuable adjunct to the ordinary water mains for fire extinction. Nearly 100 miles of hydraulic mains are now available throughout the districts in London where the most valuable property is situated, and at every point on these mains 500 H.P. could be immediately applied to a fire. In this application of hydraulic transmission the efficiency is low, and the cost per H.P. high, but the apparatus is nevertheless as near perfection as can be obtained.

An important matter in connection with transmission of power for general public use is the proper basis of charge. When it is considered what great differences there are in the cost of creating and distributing power of any kind depending on the nature of the plant, and the average output per H.P. provided, the principle of a sliding scale seems *primâ facie* to be reasonable.

What is the rate at which power must be supplied in order to render private producing-plants superfluous? Where steam power is used for hydraulic transmission it is very doubtful whether any private plant is run at a total cost of less than 1s. 6d. per 1,000 gallons at 750 lbs. pressure, which is the rate from the public mains for 3,000,000 gallons per quarter. While this rate is low for lifting purposes and other intermittent work, it is altogether too high to displace private steam-plants for driving general machinery except in special cases. To do this power must be supplied at about one-third the price, or, say, at not more than 1d. per Board of Trade unit. At present this seems impossible. If the central stations were at the collieries, and the coal and water cost nothing, the maximum saving in expenses in the case of the hydraulic system in London in 1896 would have been £5,000, and the maximum H.P. to be conveyed 2,000. The capital outlay required to convey this even 20 miles would render it impracticable. If the Kent coal field extends within 15 miles of London the problem would assume a different aspect. The experiment must apparently be first tried in the provinces.

If the power were conveyed electrically in order that it could be profitably used at the hydraulic power stations in London in place of steam, 2,000 H.P. would have had to be supplied at not more than £2 per H.P. per annum, or, on the basis of actual output, at ½d. per unit, with a load factor of 34 per cent., nearly the highest factor obtainable with any general distribution of power.

The whole question of transmission of power is dominated by the commercial factor. Every system in practice falls short of its theo-

retically obtainable efficiency, and is handicapped and confused by the multiplicity of the commercial interests involved. When seeking to obtain the highest efficiency in a given plant, specialisation and complication of parts, initial outlay, supervision, and maintenance are matters of no concern; but in the long run the pressure of these commercial elements will compel the sacrifice of mechanical efficiency. All systems are more or less useful and necessary in the areas within which power is required.

The question of long-distance transmission seems primarily a question of the capital outlay required to convey the power, and the conversion of the most economical power for transmission into other systems required must take place in the immediate neighbourhood of its consumption.

(To be continued.)

TEMPERATURE CORRECTIONS FOR DIELECTRIC RESISTANCE.

By ROLLO APPLEYARD.

In the construction of tables of temperature-corrections for the change of resistance of dielectrics, it is usual to assume the logarithmic law.* But the conventional character of that which we call "dielectric resistance," renders it very improbable that the coefficient is constant except for a few degrees of temperature; we are accustomed to find discrepancies between "observed" and "calculated" values.

The curves here given, relate to tests made upon paraffin-paper condensers,† by the "direct deflection" method, with 1 minute electrification. The temperatures are accurately determined by platinum ‡ thermometers, embedded in the wax of the condensers. Fifteen observations are plotted between 0° C. and 60° C., as shown by the small circles through which the "observed" curve is drawn. The "calculated" curve is logarithmic; its coefficient is found from the 15 observations, taking two at a time, in alternate order. A comparison of the curves shows that, even under the most favourable circumstances, there may be a discrepancy of 5 per cent. or more; hence we are led to consider (1) whether greater accuracy can be obtained, and (2) whether the calculations can be simplified.

It may be argued that the "observed" curve is wrong, and the "calculated" curve right. But, since an endless number of "calculated" logarithmic curves, all justified and all different, may be drawn to pass with equal approximation to the observed points, that argument lacks evidence. Moreover, from what is known of dielectrics, their softening and hardening, &c., we naturally look for deviations from the logarithmic law; we expect that the coefficient is not a constant, and experiment puts the matter beyond doubt. The time employed in seeking for a coefficient is better spent in adding points to the "observed" curve.

The logarithmic correction tables, with their 5 per cent. inaccuracy, expressed in seven places of decimals,* may be replaced, as follows:—From the "observed" curve, measure, with compasses or otherwise, the length of the resistance-ordinate corresponding to the required standard temperature. Express the lengths of all the other resistance-ordinates successively in terms of that unit, then draw up a table giving, opposite to each degree of temperature, the numbers thus obtained; these are the correcting divisors corresponding to each degree. With the aid of a slide-rule, such a table can be completed in an hour.

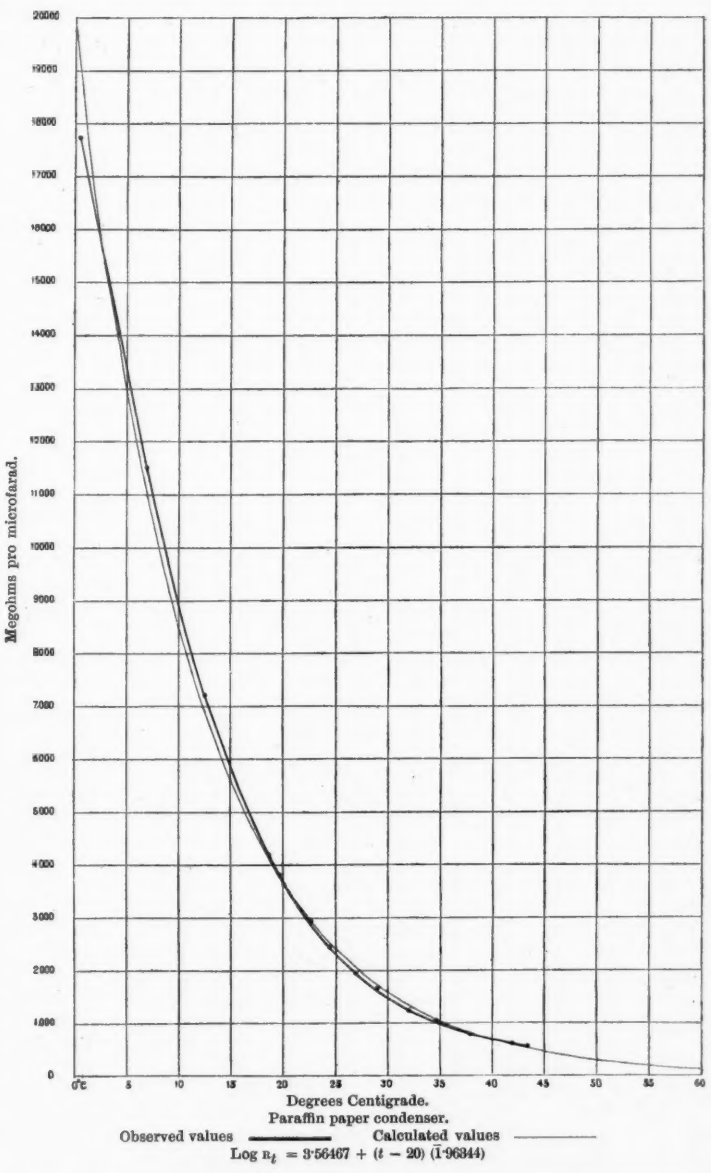
As an example, there is appended a table giving the correcting divisors, for Fahrenheit degrees, of paraffin-paper condensers.

The variations of the dielectric resistance with temperature

Silvertown Paraffin-Paper Condensers.

(To reduce the dielectric resistance at any temperature Fahr. to the corresponding dielectric resistance at 60° F., divide the observed resistance by the number opposite the given temperature.)

Temp. Fahr.	Divisor.	Temp. Fahr.	Divisor.	Temp. Fahr.	Divisor.	Temp. Fahr.	Divisor.	Temp. Fahr.	Divisor.
°		°		°		°		°	
33	3·19	49	1·67	65	0·775	81	0·335	97	0·169
34	3·07	50	1·62	66	·733	82	·319	98	·159
35	2·96	51	1·55	67	·699	83	·306	99	·153
36	2·87	52	1·46	68	·656	84	·292	100	·148
37	2·76	53	1·39	69	·625	85	·281	101	·141
38	2·66	54	1·33	70	·595	86	·270	102	·137
39	2·57	55	1·27	71	·562	87	·259	103	·133
40	2·48	56	1·20	72	·528	88	·247	104	·126
41	2·39	57	1·15	73	·501	89	·234	105	·119
42	2·30	58	1·09	74	·477	90	·225	106	·114
43	2·19	59	1·04	75	·450	91	·216	107	·108
44	2·09	60	1·00	76	·432	92	·207	108	·105
45	2·00	61	0·944	77	·411	93	·198	109	·101
46	1·91	62	0·901	78	·389	94	·189	110	·099
47	1·82	63	0·858	79	·375	95	·180		
48	1·76	64	0·820	80	·355	96	·175		



* See "Kempe's Handbook of Electrical Testing," 5th Edition, p. 440 and p. 557.

† "Dielectrics," *Phil. Mag.*, August, 1896.

‡ "A Direct-reading Platinum Thermometer," *Phil. Mag.*, January, 1896.

of other substances, such as gutta-percha or India-rubber, may approach more nearly to the logarithmic law than is shown in the curve for paraffin-wax. Nevertheless, the general argument holds; the graphic method here given is simpler and more accurate.

THE ROYAL SOCIETY CONVERSAZIONE.

We have become so accustomed of late years to hear and to see something new, in the electrical world, that it was somewhat disappointing to find last week so few electrical exhibits at the great social function at Burlington House. Out of 50 exhibits, only about 10 had anything to do with electricity. The astronomers, biologists, geologists, anthropologists, and a few other bodies not susceptible of electrical influence had evidently determined to have their innings.

Mr. Wimshurst's great influence machine was certainly the most striking exhibit (at least to the eye and the ear), in the Royal Society's rooms. Its striking distance was apparently 34 inches, but as the machine case really contained two machines joined in parallel, the sparking distance correctly stated was only 17 inches. The machine had 24 discs divided into two groups of 12 each, which were located at opposite ends of the case some 9 feet in length with redundant corners removed so as to look like a somewhat unusual design of a suburban villa. The adjacent poles of the two machines were of the same sign, and were connected to a rod passing up through the centre of the roof of the case and terminating in a brass ball about 3 inches in diameter. Two similar terminals, one near each end of the case, were connected to the opposite poles of the two machines. Both machines being simultaneously rotated by two belts, sparks of very considerable volume passed from the two outer to the central terminal. The collecting brushes in this machine were not in the usual horizontal line, but lay in lines sloping downwards from their point of intersection; an arrangement evidently made to secure compactness.

Experimental demonstration of stress effects produced by electric discharges on the surface of a viscous mixture of resin and oil were exhibited by J. W. Swan, F.R.S. The viscous mixture of resin and oil was placed between two balls about an inch apart and connected to the poles of an induction coil. A shunt gap of 2 inches length prevented the electric pressure on the resin rising above a certain amount. When the electric pressure was turned on, the viscous mass heaped itself up, or was depressed under the pole according to the sign of the latter. In the solid resin, no deformation was produced while the mass was solid, but when the resin was heated so as to be slightly softened, indented figures were formed on its surface. Dust figures formed by electric stress, coincided very closely with the indented figures. These indented figures had been developed in some cases, three months after the electric stress had been applied to the resin.

Prof. S. P. Thompson exhibited his model of the transmission of the Hertz wave, which has already been shown to the Physical Society, and shortly described in our columns. This model differs from most of the previous apparatus devised to illustrate wave motion, in that it has in itself something corresponding to the elastic medium for transmitting the oscillatory motion from one particle to another. In the model there is a horizontal row of lead balls, each of which is suspended by two strings forming an inverted isosceles triangle with the ball at its apex. The sides of adjacent triangles interlace and are tied together at the points of intersection. The consequence is, when a transverse motion is given to the terminal ball, it drags, by means of the net the next ball after it, and so a wave is propagated along the whole line. Heavy rings, with gaps to embrace the terminal balls, were suspended by three threads in a horizontal plane. When an oscillation about its axis was imparted to the oscillator, the movement was communicated to the terminal ball by the sides of the gap striking against it. After the oscillation reached the last ball at the other end, the latter acting on the gap of the synchronised resonator, soon threw it into a state of oscillation.

Mr. A. A. C. Swinton had a dark room assigned to him, in which to show his highly interesting experiments with the cathode rays. But as these have already been fully described in the Electrical Review, Vol. 40, p. 482, it is unnecessary to say anything more about them here. Experiments were also shown with his adjustable focus tubes (see Electrical Review, Vol. 40, p. 630).

Some remarkable Röntgen photographs of alloys of sodium and gold were exhibited by Mr. T. C. Heycock, F.R.S., and Mr. F. H. Neville. It is, of course well known that gold is much more opaque to the Röntgen rays than sodium. An exposure to the rays shows that the apparently homogeneous alloy is a mass of separate crystals of gold and sodium. Dilute, saturated, and super-saturated solutions were exhibited to illustrate the processes that take place during the solidification of a mixture.

One of the most interesting and newest things exhibited was the demonstration by Prof. Oliver Lodge of Zeeman's discovery of the broadening of spectrum lines by the action of a magnetic field on the source of light. Zeeman's discovery is, perhaps, the greatest discovery of the year in physical science. It may be explained by assuming that the atoms of luminous bodies have small electric charges. When these charged atoms revolve in a magnetic field the force which balances the centrifugal force of the atom is increased or diminished according to the direction of rotation. The periodicity of one group of atoms will thus be increased, and of another group reduced, according to the well known equation of centrifugal force, $p = \sqrt{\frac{F}{mr}}$. In Prof. Lodge's experiment the sodium lines produced by an oxyhydrogen flame between the poles of a powerful magnet were examined by means of a Rowland concave grating, and could be seen to broaden and become double whenever the magnet was excited. A Nicol prism showed that the light of changed refrangibility was polarised; another result that can be easily deduced from the electrified atom theory.

Dr. Gore, F.R.S., exhibited an apparatus for investigating the influence of proximity of substances on voltaic action. A full description of the apparatus and an account of the results obtained with it will be published in the *Philosophical Magazine*.

A very simple and effective apparatus for controlling the electric arc in its application to photomicrography was shown in use by Messrs. Carver & Barnard. The regulation of the arc is effected by two screws worked by hand. One screw regulates the length of the arc, and the other brings it into the correct optical axis. The holder is hinged to its base so that it can be inclined until the crater of the arc is brought into view. The result is a great improvement on any kind of automatic mechanism.

Mr. Kamm exhibited his synchronous printing telegraph apparatus which has already been noticed in the Electrical Review (Vol. 38, pages 490 and 544).

In the meeting room Prof. Ayrton lectured on electric and mechanical analogies. He exhibited a very ingenious and simple frequency meter, depending on the resonance of a steel rod overhanging the pole of an electro-magnet excited by the current whose frequency was to be measured. The length of the steel rod was varied till it resounded under the action of the magnet. The length of the rod, or its previously ascertained rate of vibration was then read off from a dial.

CORRESPONDENCE.

The "Rapid Cable."

Messrs. Houston & Kennelly, referring in their late paper on "The Insulating Medium Surrounding a Conductor; the Real Path of its Current," to the last trans-Atlantic cable laid for the Anglo-American Telegraph Company, say: "If, however, the insulation, instead of being 85,000,000,000 in each nautical mile, were reduced to about 500 ohms in the nautical mile, the leakage tailings would probably balance the tailings due to imperfect conductance, and the cable would be distortionless. The signals received would therefore be the exact counterpart of the signal sent, and an indefinitely high speed of signalling should be possible. . . . . The current strength which would flow from the receiving end to ground would be approximately 5×10^{47} times less than the current entering at the generating end. No telegraphic or telephonic instrument at the present time could

detect so feeble a current as this. Moreover, if any accident happened to such a cable, it would be impossible to localise the position of the fault unless the same occurred within a mile or two of either end."

Mr. David Cook, in his communication of March 5th last to the ELECTRICAL REVIEW, quotes Mr. Oliver Heaviside as follows:—"There are two ways I have proposed, artificial leaks and insulation of comparatively low resistance, say one megohm per mile instead of hundreds, I have no doubt that either one or the other will be done some day. . . . . You can double the speed by proper leaks, and still have enough current arriving to work by."

The introduction of the vibrator, the invention of Mr. Geo. F. Pescod, traffic manager Central and South American Telegraph Company, has so immensely increased the sensitiveness of the recorder, that I have no doubt a speed much more than double that obtainable with a well insulated conductor could be obtained by having an insulation per knotage between the 500 ohms of Messrs. Houston & Kennelly, and the million of Mr. Heaviside. The right per knotage, &c., could, of course, be determined experimentally with artificial lines. If such a cable were laid, it would be necessary to embody in it a well insulated wire, to enable localisation in case of a break. (Part 89, Vol. xix., *Journal* Inst. Elec. Engrs., London.) This well insulated localisation wire would, of course, be very light indeed compared with the working wire.

The idea of covering a heavy conductor, first with a thin covering of a good insulator, say, gutta-percha, and of then lowering the electrostatic capacity by increasing the thickness of the insulation with cheap material, finds with some more favour than the idea of a very low insulation or "leak" cable. I have no intention of entering here into any comparison in the matter, my principal reason for writing this being to point out the method in which the localisation difficulty would be obviated, should the very low insulation cable be decided upon.

H. Kingsford.

Hydro-Electric Methods in Medicine.

I have to thank "The Reviewer" for his long and lucid explanation. The light which his technical knowledge enables him to throw upon such a question must prove of the highest service to every medical man who has to deal with the human body from the electrical standpoint. In this particular instance, I do not yet feel able to acquiesce in the accuracy, or even in the feasibility, of the method he proposes. It seems that the one point of agreement between us is the proposition that the only accurate method of ascertaining the R of the body would be by the summation of the resistances of short sections of uniform conductivity.

In the first place, I have a difficulty in following his definition of "uniform conductivity." My own impression is, that by this term is meant that at any given cross section the current density is uniform. But this is certainly not so in the case of the human body, composed, as it is, of blood vessels and their contents, bone, muscle, nerve, tendon, &c., each having a different specific resistance, and varying individually and proportionately in sectional area at various cross sections. If by the term "uniform conductivity" it be meant that any short section will have the same specific resistance as the whole of the body, again I am in difficulties. For the reasons given above, it will be seen that the variation of the proportions of the component parts of the human body must of necessity alter the specific resistance of individual sections. Is it possible to obtain the specific resistance (or conductivity) of any short section of the human body? By any process short of actually severing it (*i.e.*, "surgical" sections). I think not. The various components of the body (blood vessels, bone, &c.) are more or less insulated from each other, and therefore there must be, consequent on their varying proportion of sectional area and different specific resistances, a potential difference between the terminals of any one or more of them at any given cross section. Thus: even if we pillory the body in insulating clamps, or entirely remove the water from the space between the pillories, and so ensure that the whole current pass through the particular section of the body, there will still remain an unknown and unknowable quantity—the true P.D. across that section. Now, these two quantities (P.D. across the section and specific conductivity of the particular section of the body) form the basis of "The Reviewer's" calculation, and the fact that they are not obtainable must render the whole calculation and method bad.

The only information to be got is the terminal P.D. of the whole body, the resistance (specific and total) of bath water, and the resistance of bath water and body, and I submit that it is all that is required to give the *mean* resistance of the whole body, and the *mean* current in the body.

W. S. Hedley.

May 25*th*, 1897.

I am sorry that I have not yet been able to make it clear to Dr. Hedley what I mean by "uniform conductivity." If a rod were made up by soldering together a large number of plates of different metals having different specific resistances, its resistance and consequently its conductivity per short unit length would be different at different points along its length. The resistance throughout each separate plate might, however, be taken as uniform or constant, and the sum of the resistances of the separate plates would be the correct resistance of the whole. If such a rod were insulated its resistance could be measured directly by passing a measured current through it and connecting a voltmeter to its ends. But if it is immersed in water this can no longer be done because the same current does not now flow through each section, and Ohm's law can no longer be legitimately applied to terminal measurements. I quite agree with Dr. Hedley that the different components of the body have probably different specific conductivities, and that no account can be taken of these by any external measurements; but, of course, what I meant was that the average of these unknown conductivities could be measured for the short section, and that, I maintain is considerably nearer to the truth than results obtained by the method recommended by Dr. Hedley. I am inclined to doubt Dr. Hedley's assertion that the various components of the human body are insulated from one another; but, of course, such a question could only be settled by experiment. If it should, however, be true it would give rise to more serious errors in Dr. Hedley's method of measurement than in mine. The method I recommended gives I believe theoretically the best approximation to the mean density of current in any specified part of the body, and I cannot see that there are any insuperable practical difficulties in carrying it out. In a short letter I was, of course, unable to give in detail all the approximate assumptions that were made to make calculation possible. I assumed that Dr. Hedley would see from the investigation itself what assumptions had been made. I still maintain, however, that I have shown that Dr. Hedley, by his method of measurement, neither gets the *mean* resistance of the whole body, nor the *mean* current in the body.

The Reviewer.

MANCHESTER STREET LIGHTING.

TOWARDS the end of last year, the Electric Works Committee of the Manchester Corporation decided to make an experiment in street lighting by means of arc lamps, and instructed their engineer, Mr. C. H. Wordingham, to advise them as to which portions of the city would be the most suitable for the experiment. Three open spaces were decided upon, viz, Albert Square, which bounds one side of the Town Hall; Piccadilly, which is a very fine, wide, open thoroughfare, on one side of which is the Royal Infirmary; and St. Ann's Square, which may be called the Manchester Regent Street. It was felt strongly by the engineer, that from the beginning the electric lighting of the streets should be done on commercial principles, and therefore in his report he did not recommend making a large display of light, but rather the provision of a better illumination at about the same cost as the then existing gas. Accordingly, in Albert Square the illumination is about sevenfold, in Piccadilly threefold, and in St. Ann's Square fivefold that afforded by the older system. In Albert Square 12 10-ampere Brockie-Pell lamps are fixed. They are so arranged that six can be extinguished at 11 p.m., and the remaining six left burning. They are supplied from the ordinary five-wire network, and the switches are fixed in the base of one of the pillars. Only two switches are used, and they are operated by the ordinary gas lamp lighters.

Although there is thus the utmost simplicity in working, the connections are somewhat complicated. When all lamps are alight, eight burn in series on 400 volts being connected to the two outer

distributors, while the remaining four are connected between the middle conductor and one outer. When half the lamps are extinguished, the six left alight burn in series on 300 volts across one outer conductor and one of the intermediate conductors. The arrangement adopted is very economical in wiring, and secures efficient burning. The pillars are of very substantial design, and the lamps are fitted within canopies.

In Piccadilly six Crompton-Pochin arc lamps are fixed. Four are attached to overhanging arms, the object being to throw the light forward to the roadway, as the whole of the lighting is done from one side of the street. The remaining two lamps do not overhang, but are placed in crutches. These two lamps are each fixed in a refuge. They are so arranged that two lamps can be extinguished at 11 p.m. When all are burning the lamps are connected six in series on 300 volts, being connected to one outer conductor and one of the intermediate conductors. After the two are extinguished, the remainder burn on 200 volts between the middle conductor and one outer. In St. Ann's Square two Brockie-Pell lamps, connected in the ordinary way to a 100-volt circuit are fixed. In all cases the lamps are guaranteed to burn 40 hours, and each is provided with an automatic cut-out. On Thursday last week the street lighting was inaugurated, and the various groups of lamps were turned on by the Lord Mayor, and by Alderman Gibson, chairman of the Gas Committee, Alderman Higginbottom, chairman of the Electric Works Committee, and Councillor Phythian, deputy-chairman of the Electric Works Committee. They all started up without a hitch, and the effect was very satisfactory.

MOTOR TRAFFIC.

The sudden disappearance of all superficial interest in the motor car has doubtless been caused by the jobbery which has been so prominent a feature in the promotion of motor vehicle companies. But there is probably a sound basis to the motor car industry when purged of its accessory fungoid growths. The appearance of another paper by Sir David Salomons seems to mark a new beginning, and is not ill-timed, just when the froth has been blown away, and disclosed the amount of actual liquor really present. Sir David has taken a genuine and honest interest in the motor car, and has become possessed of all the literature he could obtain on the subject, and has studied this, and comes to the conclusion that few recent patents are original, and that the tendency of to-day is all in the direction of the better types of vehicle existing in the decade 1820—30, when, we all seem to have forgotten, the self-propelled road vehicle had become fairly perfect, and was only run off the road by the newer railway which dominated the market, and for years absorbed all the country's spare capital and best energies. To-day we possess better materials and greater facilities for construction, but we can hardly do better than start where our grandfathers left off. Sir David states that there is considerable wonder that the motor vehicle demands so large a mechanical horse-power to drive it—so much more than the flesh and blood horse. We have more than once ventured to state in these columns the very common sense proposition that when a horse is starting a vehicle, it exerts very much more than 1 horse-power. A contemporary which aims at being exceeding critical, and ends in being foolish, objected that no power was being exerted when a horse was starting because there was no motion. To ordinary intellects it will be perfectly obvious that a horse, which at 6 miles an hour exerts the equivalent drawbar pull of the mechanical horse-power, or say 63 lbs., will be capable when fairly hanging on the collar of putting many times 63 lbs. pull on the traces. To the horse this represents expenditure of energy, though no work is being done exactly as when a turbine starts, and the water flows through in huge volume with very little production of motion, or when the electric motor tries to move and electricity flows to waste at a large torque. It is in this sense that Sir David looks upon the power of the actual horse, and sees good reason for mechanical power of much greater amount. Obstructions on a hill, for example, demand an actual lift up of the vehicle by an inch or half an inch, and the horse simply hangs himself in the collar and lifts the vehicle by superior dead weight. Looked at as a lever and weight, the horse is a cantilever supported on the ground by its end post, to wit, the hind feet. The traces are attached at the outer end, and the weight acts largely between this point and the fulcrum. Hence the wisdom of a sack of wheat upon the beast's back to help it up a hill with a heavy cart. If a horse could only be attached by its middle instead of at the neck, it would pull a much heavier load up hill. The heavy head of the draught horse has a special value.

Referring to wheel diameters, Sir David emphasises the value of large wheels; but he does not make it clear that they surmount obstructions more easily because they spread the period of rise over a longer period. An obstruction of an inch in height is met by a large wheel at a greater distance from the point of contact of wheel and road than is the case with a smaller wheel, and the difference represents ease in raising the load. Similarly a pulled vehicle will move easier over obstructions than a pushed vehicle, unless special care be taken as to the direction of the pull and push. Self-propelled vehicles are in the position of pushed vehicles, and this adds to the horse-power required, and further, the engine of a self-propelled car has got to furnish power to move itself. So has the horse, but this is never taken into account, yet it must amount to something considerable. Sir David does not think much of pneumatic tyres for motor vehicles, for he thinks ordinary steel tyres are quite good enough, and give less draught resistance with good vehicle springs. The function of the spring is, of course, to allow wheels to run over lumps without raising the C.G. of the vehicle. His own experience is that steel tyres give less tractive resistance than do pneumatics. Why indeed do pneumatic tyres burn under heavy loads if it be not that heat is in some manner developed from the amount of energy somehow swallowed up by the tyres. For this reason Messrs. Dion and Bouton fell back on solid tyres. Pneumatic tyres cannot, in fact, be judged by their behaviour on bicycles under mere trivial loads of 60 to 100 lbs.

Reverting to the tractive effort necessary, the engine cannot, like the horse, exert any weight. The only equivalent to weight is the getting up of speed and putting in a friction clutch. There is no reserve of power in the oil or gas engine type of motor; there is in electric motors which can also be started and stopped easily, a virtue not possessed by internal combustion engines, although possessed by the steam engine to which Sir David still pins his faith.

As we have previously pointed out, both oil engines and electric motors can be given a reserve of power by making them large enough. This involves uneconomical working at anything less than full load. The steam engine, on the other hand, may be had of a size which will usually work at an economical rate, but which by working short periods at less economical rates will perform work much greater than the normal. This is a very serious advantage to the credit of the steam engine.

Granting that railways have been successful because of the rails, or very largely so, it does not follow that the steam engine cannot be adapted to highway purposes. As regards the idea of a road engine laying its own rails, Sir David very properly characterised as disgraceful that the Patent Office should, under the false pretence of granting patents for oft patented devices, take money from patentees of devices for this object, which have been taken out over and over again. He states there is no great value in these self-rail laying devices. Wheels can be made to accomplish the same object under certain conditions. Still these self-rail layers are not to be altogether despised. It would appear that Hancock's steam carriage of over half a century ago is the model to-day of M. Serpollet's steam cars, and Sir David considers it cannot be improved upon, which is at once a compliment to Hancock and to English engineering ability, and a curious fact. English manufacturers are, we are informed, busy on road steam engines, notably Messrs. Toward & Philipson and Messrs. Thornycroft, but up to the present, the carriage which has been brought nearest perfection is that of M. Serpollet, who is building now for Sir David. There are no patents on the engines or on the disposition of parts, nor are these capable of material improvement. They have been common knowledge for 70 or 80 years. The boiler and furnace, however, have been improved. Waterless boilers are not new, but Serpollet has devised one that is cheap and effective, yet simple. It consists of tubes flattened and bent into a U shape, so as to have a narrow horse-shoe formed cross section for steam space. These tubes are heated by petroleum, and they are very thick, so that they form in themselves a store for heat, the tubes nearer the fire being thicker than others further away. Ordinary heavy petroleum is used for the fire, and the minimum weight is thus secured. Much weight has thus been saved on the older carriages, and some of this has been put into the more heavily stressed portions, and while old carriages weighed at least 2 tons, a new one equally strong would weigh only 10 to 20 cwt., though they are made heavier for extra strength as above just stated. Thus the modern steam carriage weighs 18 cwt. Its body is triple. In front the box, in the rear the boot, like that of a phæton, with engine and boiler cupboards left and right. Between is the carriage proper, be it the body of a Victoria, a brougham, or a van, and arranged to be easily removed, so that a single power frame serves for any style of vehicle.

The engine is a double tandem, geared down by a chain placed midway on the axle just as Hancock placed it. The engine will work at from 4 to 10 H.P., and the boiler pressure can with safety be raised to 17 atmospheres if required.

Methylated spirit is used in small quantity when lighting up, and no smoke is made when the burner is being prepared for lighting. When a stop of any duration is being made, the main burners are shut off, and only an auxiliary burner is kept going; this keeps the main burners hot ready for instant start. The same can be done when running down hill. The heavy petroleum which we are told can be bought at 3d. to 4d. per gallon, need not exceed 1½ gallons per hour for a 4-person carriage at 12 miles an hour on average roads. This represents one halfpenny per mile run, or one-eighth of a penny per passenger. Six minutes is the time necessary to start from cold. What of renewals? Usually the lower tubes require, perhaps, occasional renewal. The cost is 30s., and if much used, once or even twice a year, renewal would be necessary? The whole boiler only costs £30, but will cost less in England, and a boiler will last many years. The burners will cost but a few shillings to renew, and once a year should be at most necessary.

Instead of crawling up hill as with oil engines, a steam carriage will go up any horse and carriage hill at 12 miles an hour with ease. Moreover, in crowded traffic the engine will start and stop as easily as a horse. All steam used is condensed so that a very little water will last for days, and the scaling up of the narrow tubes can be dissolved by using rain water, which, when there will be so many empty petroleum barrels about, can well be caught, country house fashion, in a 40 gallon cask.

In the steam engine there are no valves to be ground up, no dangerously inflammable spirit to store, no smell, vibration, or ignition tubes, and there are no accumulators to re-charge, and the village smith can do any repair that may be possibly required. Also any ordinary man can master the working in a few hours, and the country is full of men who have been more or less accustomed to steam-power, which cannot be said for oil motors, which are much more complex, and we have seen practised hands at a loss to know how to locate the reason for a motor refusing to run. All this is very true.

Once set it with its valve gear correct and a fairly tight piston, and a steam engine will start and run without hitch.

Referring to the vibration due to the explosive strokes of oil engines, it is stated to be preferable to endure this than to incur the risks inherent to the complications necessary to cure or ameliorate it, such as counterbalancing the explosion by an equal and opposite cylinder with concurrent explosion. The oil vehicle is only comfortable when running at a considerable speed, and then only is it fairly uniform in velocity, the motors having a great tendency to race at lower speeds. With his own oil carriages Sir David has found danger on hills when running on snow, the carriage slipping backwards, even when the wheels turned forward, and he recommends safety spiked rods from the rear of the vehicle, pointed at an angle of 45°. These will prevent backward movement, and should always be lowered when hill climbing.

Why is not electricity in competition at present in the motor carriage industry? The reason simply is that there is yet no accumulator or primary battery that can be satisfactorily employed. Primary cells are troublesome and costly. Secondary cells are too heavy, or if made light, too costly in repairs. It is not to be believed that they will endure the vibration of a road vehicle. Wet cells are out of the question, and dry cells which cannot keep their plate surfaces clean have not the long endurance at reasonable power that is possessed by wet cells, but our author speaks well of the fibrous celluloid separator of Mr. Swan. Calling the cost of electric energy 3d., it will cost at least 4d. if it is to be carried on a moving vehicle. Now, $\frac{3}{4}$ unit is 1 horse-power, and the H.P. hour will, unless over 6 H.P., use up at least a whole unit, so that the cost is 4d. per H.P. hour, a cost so enormous compared to steam as to put electricity out of the market, and we need not pile Ossa upon Pelion by more than hinting at the re-charging difficulty. Benzine gas runs out at 3s. 6d. per 1,000 cubic feet. A benzine motor only costs, therefore, a fourth of electric power. Steam raised by petroleum at 6d. per gallon works out at about the cost of benzine, and in quantity petroleum can be had for 3d. What is the perfect or ideal accumulator which can be produced to-day, though at forbidding expense? It is hinted at, but not described, while the cheap ideal may "depend possibly on some new principle," a doubtful offer we fear. But while he thus speaks discouragingly of electric cars, he would not imply they have no field. A professional man who must have a vehicle, yet employs it but a small part of the day in actual motion, can afford a heavy cost for energy when moving, for his horse goes on costing when standing still. But certain conditions must accompany successful use:—

1. A guarantee from a company to keep the accumulator in order.
2. Recharging conveniences.
3. Distance run per day not to exceed the capacity of one charge.

One M. Duracq, whose electric carriage is the best our author has seen, shows electric energy to be cheaper than horse-power, but he takes too small a power for hauling 1 ton at 8 miles per hour, and ought, in our author's opinion, to have trebled his allowance. His figure might be true on asphalte, but in any case M. Duracq makes no allowance for frequent restarting. Taking, simply, a continuous day's run, M. Duracq actually makes the cost of energy 40 per cent. less than horse-power, but in practice it will be much greater. His figure is only 35 kilogrammetres per ton for speeds of 12 to 15 kilogrammes per hour, or less than one-half horse-power, a figure much too small, except under very favourable conditions.

Coming, now, to the power of the engines required on motor cars, the speed must be calculated as an average, whether the country be level or otherwise, and the roads good or bad, and climate must be considered also. Fix, say, on a 1-ton vehicle at a speed averaging 12 miles, then must the power be fixed to run this load in all weathers, and to climb every hill of 1 in 10 at the rate, while hills of 1 in 5 must be within the power to climb, but at less speed. Other conditions are, simple mechanical construction, freedom from danger to public or occupants, strength of make, freedom from dangerous fuels, ease of repairs as by a country smith. The author's experience leads him to provide a possible 10 horse-power for each ton of load, and as a prominent electrician writes us, a horse does a great deal more than 1 horse-power for a time without "bustin of hisself," this estimate is perhaps not too high. As regards claims for high speed, benzine cars at 60 miles per hour, made by company promoters, these are all worthless. The real test is to mount a hill of 1 in 10 for 5 miles with the thermometer at 90° in the shade at 12 miles per hour. Any test short of this is worthless, or if a less speed be asked for, let the test be at the speed demanded.

Telford showed that a 21-cwt. waggon had the following traction resistance: 33 lbs. on well made pavement, 65 lbs. on old flint road, 147 lbs. on gravel road, 46 lbs. on a broken stone road on a rough pavement foundation, and the same on the broken stone road on a foundation of concrete of Parker's cement and gravel. Babbage gave $\frac{1}{77}$th of load for well paved roads, $\frac{1}{35}$th for gravel, and $\frac{1}{15}$th for fresh earth. He found $\frac{1}{24}$th for loose sand, $\frac{1}{25}$th for dry meadow, $\frac{1}{33}$rd for hard macadam. Again, a traction engine of 18 tons, drawing 18 tons on a fair level load, must indicate 30 H.P. to travel 4 to 5 miles per hour, and a 12-ton engine, drawing 25 tons, indicated 40 H.P., and one of 15 tons 50 H.P., when drawing 32 tons.

The claims of Frenchmen, and even of Germans, to have made road vehicles a success is quite unfounded. Englishmen made the industry a practical and commercial success, but it was legislated out of existence in 1830, and finally killed by the definition of a locomotive in the Act of 1865. But Hancock and others could to-day run their coaches, and we can but add to them by better materials and tools, just as to-day our rail locomotives are really the same engines as those of 1830. There are no real differences, nor must we expect some extraordinary invention to suddenly make road locomotion a pronounced success. This we would endorse. Few such inventions ever are made. The Bessemer process approached being so; so did the Thomas-Gilchrist process in steel makes. Weldon's process in chemistry sprang Minerva-like from the inventor's brain, but these are the unexpected. In mechanical, as distinguished from chemical or physical processes, all progress is slow and tentative. Practice and experience alone can bring matters up to a better commercial condition, and our great manufacturers may be relied on to bring the whole matter to a happy issue, in conjunction with such newly founded factories as may be honestly founded, but we are asked to believe that steam has to-day no real rival.

Tyre breadths should be 2 inches wide for the first ton of load. An inch should be added for each ton up to 3 tons. Thus a 3-ton carriage would have four wheels of 4 inches each breadth of tyre, and this is wide enough for greater weights on the high roads. Sir David does not hold with the opinion expressed by Telford, Gurney and Macadam, that wheels do less harm than hoofs, or why are ruts worse than hoof tracks? Only when the road is wide and quartering takes place will the wheels wear the surface evenly.

The evidence of Telford, Gurney and Macadam, before the Parliamentary Committee in 1831, was to the effect that steam carriages were a success, and likely to remain so. Where can electricity make itself a success in traction work? This question is briefly answered by our author, who states that if electric traction were only applied to our existing canals they would be made far more useful and profitable. Indeed, the use of a miserable horse on a canal that must have cost much money always seems to us like making a poor use of large tools. Not merely on roads, but on railroads, the self-propelled vehicle has a field. The French Serpollet Company have built cars of 40 to 50 seats capacity with engine power to run at 30 miles velocity, and the cost is but a third of an ordinary train, and the capacity quite enough for light trains. There must be many such openings on our English railways. The French and German laws as to power traction on roads are far more lenient than our own, and in England, owing to the laws, only slow and heavy traffic has prospered, and many thousands of traction engines are now used throughout the land. The recent revival of self-propelled vehicles, however, arose from the competition set going by the *Petit Journal*. The French agitation set up an English sympathetic vibration—Keely fashion—and thus came to be passed our new Act; but the expectation of crowds of vehicles being at once on the roads has, of course not been fulfilled, partly, indeed, by reason of the claims set up by *some* of the motor companies. There is, however, room for real enterprise.

Touching patents, the blemishes of the patent law enable anyone to take out a patent, and then to bully or threaten supposed infringers, as to which Sir David had much to say, but he repeated his well-known Liverpool saying that "no patent worth the paper it is written upon exists in connection with self-propelled traffic."

(To be concluded.)

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending May 25th, 1896.	£	s.
Albany. Teleg. mat. ...	1,310	0
Amsterdam	80	0
Bombay	171	0
„ Teleg. mtl.	42	0
Boulogne	33	0
Bremen	10	0
Callao. Teleg. cable ...	1,033	0
Calcutta	92	0
Canada	15	0
Cape Town	39	0
Colombo. Telephone ...	35	0
Delagoa Bay. Teleg. mat.	66	0
Durban	30	0
East London	413	0
Flushing	32	0
Hong Kong. Teleph. mat.	39	0
Launceston	75	0
Labuan	17	0
Malta. Teleg. mat. ...	62	0
Melbourne. Teleg. mat.	27	0
Montreal	30	0
Odessa	29	0
„ Teleg. mat.	436	0
Port Elizabeth	31	0
Port Said	7	0
Rangoon	34	0
Rio Janeiro. Teleg. mat	5,285	0
Rockhampton	80	0
St. Petersburg	93	0
Shanghai	22	0
„ Teleg. mat.	9,434	0
Singapore	267	0
Stockholm. Teleg. mat.	164	0
Sydney	123	0
Valparaiso. Teleg. mtl.	1,010	0
Wellington	216	0
Yokohama	221	0
Zanzibar. Teleg. mat.	60	0
Total	£21,153	0

Week Ending May 25th, 1897.	£	s.
Alexandria. Teleph. mat.	75	0
Amsterdam	150	0
Bombay	7	0
Brisbane. Teleg. cable...	1,217	0
„ Teleph. (joint boxes)	420	0
Buenos Ayres	25	0
Calcutta	19	0
Cape Town	580	0
Christiana	17	0
Copenhagen	21	0
Durban	729	0
East London	46	0
Hamburg	150	0
Madeira	526	0
Melbourne	229	0
Piræus. Teleg. mat. ...	40	0
Port Elizabeth	8	0
Shanghai	26	0
„ Telephone mat.	47	0
Singapore	180	0
„ Telephone mat.	31	0
Sydney	70	0
Wellington	888	0
„ Teleg. mat.	248	0
Total	£5,749	0

Amendment of U.S. Patent Law.—Messrs. E. P. Alexander & Son, patent agents, of 19, Southampton Buildings, Chancery Lane, W.C., are circularising to the effect that an Amending Act has just been passed by the United States Congress, and will come into force on January 1st, 1898. Some changes of great importance are introduced by this Act, and attention is directed to the following provisions, which should be of especial interest to British inventors:—(1) Patents issued after January 1st, 1898, will not be limited in term by prior foreign patents. (At the present time a U.S. patent expires with the prior foreign patent of shortest duration, but in future it will run for the full term of 17 years.) (2) Public knowledge or use of an invention in the U.S.A. prior to applicant's invention or discovery thereof; or prior patenting or description of an invention in any printed publication in U.S.A., or any foreign country, before applicant's invention or discovery thereof, or more than two year's prior to the filing of the application for patent therefore in the U.S.A., will bar the issue of a valid patent. (3) Inventors must file their applications for U.S. patents before the expiration of seven months from the date upon which the first application for a foreign patent was filed upon the same invention, or no patent will be granted. (Hitherto a valid U.S. patent was procurable at any time during the life of a foreign patent, provided the invention had not been in public use or on sale in the U.S.A. for more than two years before the U.S. patent was applied for.) (4) All applications must be completed and prepared for examination within one year from filing. Applicants must prosecute their applications within one year after any action therein, of which notice shall have been given, or such application will be regarded as abandoned. Messrs. Alexander add:—"From the foregoing you will see that in future it will be necessary to decide upon the question of applying for a U.S. patent as promptly as in the case of French and German patents, otherwise a valid U.S. patent (generally the most valuable of all foreign patents) will be unprocurable. If you are thinking of protecting in the U.S.A. an invention already patented here, you must apply before the end of the current year, or Section 3 above quoted will bar the issue of a valid U.S. patent."

Bankruptcy Proceedings.—At a sitting of the London Bankruptcy Court held last Friday, before Mr. Registrar Brougham, George Frederick Lee, electrical engineer, lately trading at 111, Sydney Street, Chelsea, applied to pass his public examination upon accounts showing debts £191 5s. 3d. and assets £19 11s. 9d. The debtor said he was formerly in the Royal Engineers, where he acquired experience in electrical work. In May, 1895, he entered into partnership with Mr. Hancock in a business of electrical engineers at 111, Sydney Street. Mr. Hancock retired in September, 1895, and witness continued the business by himself until last January, when the landlord put in a distraint and sold off the stock and effects. The examination was concluded.

Business Transferred.—Messrs. Bulman & Allman, of Haworths Buildings, Cross Street, Manchester, advise us that they have taken over from Mr. R. C. Douglas the business of the Manchester Electric Company. Electric lighting, transmission of power, and other electrical work will be undertaken. The old title of the company will be adhered to and Mr. Douglas is not connected therewith.

Business Announcement.—Mr. C. M. Downie, whose name will be remembered in connection with the E. & S. United Company, has commenced business in conjunction with Mr. F. W. G. J. Adams, under the style of Downie and Adams, 24, Newman Street, Oxford Street, W. The firm will trade as electrical suppliers, making special lines of incandescent lamps, electricity meters, safety lamps, and primary batteries. A price list will be issued shortly. Mr. G. C. Murray is also associated with the firm.

Crompton's Works.—The new works of Messrs. Crompton & Co., at Chelmsford, are making rapid progress, and the two large engines by Messrs. Marshall, of Gainsborough, are about to be put down.

Electrically Driven Tools.—We learn from the *Halifax Guardian* that Messrs. J. Butler & Co., of Halifax, are now fitting machine tools manufactured by them with electric motors, and have only recently completed several small tools, including lathes, drilling and shaping machines, so fitted, for shipbuilding shops.

Jubilee Illuminations.—Messrs. Rose & Bird, Limited, of 24, Stamford Street, S.E., are making a speciality of incandescent lamps for Jubilee illuminations, of 100 C.P., consuming 1 to 1¼ watts in ordinary sized bulbs, and fitted with either B.C. or E.S. caps. They have also manufactured specially for next month lamps of high efficiency, averaging from 50 to 100 hours. This firm have also issued a list of the incandescent lamps made by them at Stamford Street, and we observe that after exhaustive experiments, they are now supplying a reliable high voltage lamp of 8 to 100 C.P. The list contains illustrations of these and various other lamps, also efficiency curves.

We understand that Messrs. J. C. Lyell & Co., of Victoria Street, have secured several contracts for electrical street illumination in connection with the Jubilee celebrations. Messrs. Lyell are selling their incandescent lamps for illuminations at reduced prices, as they are having their warehouse rebuilt and wish to dispose of the lamps in stock to avoid their removal.

Messrs. Smallwood & Co., of 84, Townshend Terrace, Richmond, are making a sliding contact rod and connector for use in the electrical illuminations.

Liquidation Notice.—A general meeting of J. E. H. Gordon & Co., Limited, will be held at the office of the liquidator, Mr. J. D. A. Norris, Suffolk House, Laurence Pountney Hill, E.C., on Tuesday, June 29th, at 12.0 noon, to hear an account of the winding up operations.

Soar's Patent "Dovetail" Brushes.—Messrs. F. W. Potter & Co., of Phipp Street, London, E.C., are supplying dynamo brushes made under this patent, the advantages claimed for them being that they are exceptionally durable, and require the minimum of attention. The ordinary folded and stitched wire gauze brushes wear elliptical in section at the ends in contact with commutator, and also turn up at the points, which require to be trimmed and adjusted frequently to prevent sparking and consequent damage to commutator. The "Dovetail" brushes are made of wire gauze so folded that

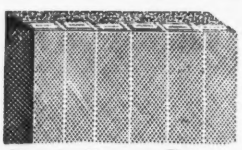


FIG. 1.—BACK OF BRUSH.

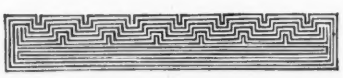


FIG. 2.—SECTION.

the part intended to face the commutator consists of plain layers of gauze to the extent of about one-half the thickness of the brush, the other half consisting of about an equal quantity of gauze folded or corrugated at a right angle, or nearly so, to the plain layers, as will be seen in fig. 2. Although at first some care must be taken in fitting the brush with exactness, it will, after once being properly adjusted, run for months without being touched.

The Telephone for the Sick Room.—The General Electric Company, Limited, have devised a means of establishing communication between rooms in which infectious diseases exist and the outside world. The small telephone shown in the illustration answers this purpose, and it is claimed to be an admirable addition

to a nurse's outfit. It is known as the "Diamond Jubilee" portable telephone. In addition to its utility as a sick room accessory, it is expected to be very useful for purposes of communication under any condition where a portable telephone is required, without the trouble or expense of a great deal of fixing.

The Wing Electric Fan.—We give an illustration of the latest pattern of this well-known fan with electric motor attached. It is said to take comparatively little current, and requires no skilled attention. The makers, Messrs. F. W. Potter & Co., of Phipp Street, E.C.,

point out that it is not economy to run a fan at excessive speed. Doubling the speed of a fan does not double the output of air, while the power required is increased six-fold. The motors to these fans are therefore limited to from 550 to 900 revolutions per minute, securing both economy in working and absence of noise.

Reflector.—We have received a sample of the Xtralite reflector, introduced by the General Electric Company, Limited, lately. This sample is made of glass, green on the outside, and white on the inside. This gives a very pleasing effect, and is suitable for reading lamps, and we are told that the introduction of this reflector, which has already attained such success in this form, has met with, if anything, more approval than the porcelain pattern originally introduced by the above mentioned firm.

Transformers.—Messrs. Miller & Woods, of Gray's Inn Road, have issued a list of their various types of transformers, illustrating and particularising sub-divided and small regulating transformers for lamp testing, high tension step-up transformers, and medical cautery and lamp transformers.

Utilisation of Water-Power in Italy.—A company has just been formed in Milan with a capital of no less than £320,000, to be known as La Società Lombardi per la Distribuzione di Energia Elettrica, to acquire and exploit certain concessions granted for the utilisation of certain available water-power in Lombardy.

ELECTRIC LIGHTING NOTES.

Bolton.—At the Bolton Town Council meeting on Saturday, Alderman Miles, Chairman of the Gas and Electric Lighting Committee, referred to the progress made during the past financial year at the Electricity Works. He said that from the profit and loss account they would see that a sum of £1,157 11s. had been charged for interest on mortgage debt, £138 3s. 11d. as interest paid to bankers, and £1,103 6s. 9d. in repayment of loans. These were particularly heavy charges against the department, but in spite of them the net loss on the year was only £102 18s. 1d. It was therefore reasonable to anticipate that next year they would have a profit in this department. The accounts show that for the sale of electricity £3,736 16s. 6d. was received as against £2,077 in the preceding year; £93 3s. 11d. for rental of hired meters as against £46, and £656 10s. 5d. from the fittings department as against £328—the total receipts being £4,486 10s. 10d. The principal items on the expenditure side are grouped under the following heads:—To generation of electricity, £1,517 11s. 11d.; distribution of electricity, £26 1s. 11d.; management expenses account, £361 11s.; rent, rates and taxes, £226 13s. 6d.; insurance, £26 10s. 10d.; and deputation expenses, £31 18s. 1d.—the total being £2,190 7s. 3d., leaving a balance of £2,296 3s. 7d. to be carried to profit and loss account, as against £794 in 1896. The disposal of the gross profit as per revenue account is explained in Alderman Miles's remarks. The number of consumers is 237 now as against 117 at the end of the last financial year. The following table shows the gross profits and appropriation of the same since the establishment of the works:—

Year ending	Gross profits including bank interest.	Interest on loans.	Repayment of capital.	Nett loss.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
March 25th, 1895 ...	945 4 6	... 956 13 1	580 8 8	591 17 3
March 31st, 1896 ...	794 4 5	... 1,013 13 6	834 14 5	1,054 3 6
March 31st, 1897 ...	2,296 3 7	... 1,295 14 11	1,103 6 9	102 18 1

Bradford.—The members of the Bradford Scientific Association visited the Corporation Electricity Works last Friday, and were conducted over them by Mr. S. T. Dalton and Mr. Wm. Jones.

Brighton.—The Town Clerk is to report as to obtaining powers to supply electric current to premises outside the limits of the borough.

Cardiff.—The Lighting Committee recommends the appointment of a salaried collector of electric light accounts, instead of a collector on commission.

Chester.—The Council is going to extend the mains down a number of thoroughfares.

Dundee.—The tenders for the electric lighting plant required by the Council have been referred to a sub-committee and the engineer for consideration and report.

Ealing.—For current to be used for Jubilee illuminations, the Council has decided to charge 4d. per unit. Mains are to be laid in the Avenue, Hanger Lane and Madeley Road at a cost of about £2,000. The applications for current for these roads represent 10 per cent. on the outlay.

Edinburgh.—The Electric Lighting Committee recommends the Council to extend the mains to Murrayfield and to the tramway terminus at Newington, at a cost of £1,500 or thereby.

Epsom.—The District Council have been discussing the electric light question, and have instructed their clerk to ascertain the cost of having a specification prepared.

Folkestone.—Last week the Council received and approved of the draft agreement for the transference of the electric lighting order to the Folkestone Electric Lighting Company.

Fareham.—The electric lighting works resulted in a loss of £845 for the year ended March 31st; the earnings being £345 11s. 8d., and the expenditure £1,385 19s. 9d. The amount formerly paid to the company (£550) for lighting the public lamps should, however, be deducted from the deficit; besides which, additional lamps have been put up, the public offices also being lit by electricity.

Glasgow.—The Corporation has accepted the offer of Mr. Richard Miller to purchase the 106 Brush arc lamps now used for lighting the street circuits. He will pay £3 10s. each.

Kensington.—At the last Vestry meeting the Special Purposes Committee brought forward a communication from the Kensington and Knightsbridge Electric Lighting Company, intimating that if the necessary alterations were made to consumers' wires and fittings, to allow of the pressure being increased from 100 to 200 volts, the charge would be 5½d. per unit instead of 6d., and that the charge from July 1st next would be further reduced to 5d. per unit, whether the house was furnished with the higher pressure supply or not. The committee learnt from the lighting engineer that a considerable saving would be effected in the cost of lighting at the Town Hall if the suggestions of the company were acted upon. They accordingly recommended that the necessary alterations to the fittings be carried out; that the lighting engineer be instructed to prepare a specification for the carrying out of the alterations, and that tenders be invited for the execution of the work during the summer recess. This recommendation was adopted by the Vestry.

Llandudno.—At the last Council meeting Mr. Preece's report on the electric lighting and refuse destructor scheme was read, and in it the necessity of taking prompt action with a view to having the plant ready by the 1898 season was emphasised. The scheme is to be gone further into immediately. The estimated cost is £30,000.

Liverpool.—The Liverpool Gas and Electric Fittings Company are to fit up the premises of the Globe Furnishing Company for 20 arc lamps of 10 amperes each and a large number of incandescents; also a private house in Abercromby Square with 150 lights, including some very elaborate electroliers and other fittings. The Company is also to fit up for incandescent electric lighting the warehouse of Messrs. Harrison & Poole, and the Clock Hotel, Liverpool, also Charlton Buildings, Manchester.

Manchester.—The following notes on the progress of the electric light works of this town will be read with interest:—The works were first opened for the supply of current in July, 1893, and by September of that year there were 82 consumers connected, with 8,000 lamps. The capacity of the plant first put down was sufficient to maintain 40,000 lamps simultaneously. By March, 1894, this number of lamps was reached, 40,000 lamps being connected in the premises of 416 consumers. The committee at once proceeded to put down additional plant capable of supplying 16,000 lamps, but by the following March (1895) the number of consumers had increased to 741, and the lamps to 66,914; so that in spite of the addition already made, the capacity of the plant was still too small to supply the demand. The committee, therefore, decided to make a very large extension, and ordered eight new engines and dynamos, sufficient to supply an additional 64,000 lights, thus bringing the total capacity of the station up to 120,000 lamps. The demand, however, continued unabated, and by March, 1896, the number of consumers had swelled to 1,148, with a total of 103,002 lamps, and by March, 1897, when the erection of the new plant was completed, its capacity was already exceeded, the consumers numbering 1,581, and the lamps 143,398. Inasmuch as there was no sign of diminution in the rate of increase of consumers, it was imperative to take immediate steps to supply at least another 50,000 lamps during the winter of 1897-8. Seeing that the existing engine room was now wholly filled with plant, and there was no time to build a new station, the committee, acting on the advice of their engineer, determined to remove six small engines and dynamos, since these were now too small to be of any practical use, and to replace them by two very much larger generators. The advantages of this course were manifold, not the least being that it was possible to develop 5,000 H.P. by means of plant occupying no more space than the old, which only developed 600 H.P. As the first step in this extension, one generator capable of supplying 50,000 lamps has been ordered, and is now in course of construction. This new generator presents many points of interest. In the first place, it is an entirely new departure in this country, though generators of the same kind have been in very successful operation on the Continent and in America for very many years past. It is by far the largest continuous current generator in Europe, and there is every reason to believe that it will be one of the finest examples of a combined engine and dynamo that has yet been constructed, either in Europe or America. Its efficiency, it is believed, will be extremely high, and considerable economy may be expected from its use. Turning now to some figures, at the present time there are the equivalent of 145,962 lamps of 8 candle-power connected to the mains, and there are the equivalent of 12,840 awaiting connection. There are 1,615 consumers connected and 36 waiting for a supply of current. As to the details of consuming devices, there are actually connected 121,736 incandescent lamps, 1,211 arc lamps, without reckoning those public lamps to be turned on by the Lord Mayor last week, and to which we refer in another place, and 135 motors aggregating about 235 H.P. It may be mentioned in connection with the work in hand, that there are 18 motors aggregating 110 H.P., and there is a prospect of a very large demand for motors in addition to these, although not actually applied for. During the year, between March, 1896, and March, 1897, there were added to the mains 40,132 lamps, or an average of 770 per week, and the rate of increase was remarkably steady throughout the year. The total output of current has increased very largely. In the first nine months the quantity sold was 439,379 units. The year ending March, 1895, this had increased to

1,168,382 units, and in March, 1896, to 1,748,244 units, while in March, 1897, the enormous amount of 2,508,588 units was reached, showing an increase of almost 50 per cent. over the previous year. The Manchester station is now the largest single station in this country, with the one exception, of the City of London Company. The large increase in the number of consumers already referred to was due in large measure to the rapid extension of the mains. The original area of supply was bounded by Portland Street, Piccadilly and Market Street, Deansgate, and Peter Street. Extensions were soon made to Whitworth Street, and the streets leading from it to Portland Street, also to Oldham Street, High Street, and Victoria Street. Then mains were put round Swan Street, Withy Grove, and Corporation Street. The next extension was a very large one, comprising Oxford Street as far as High Street, and Cavendish Street and the whole of the Stretford Road within the city. Victoria Park was then added. In March, 1897, distributing mains were laid in about 26 miles of street, of which 10½ miles were laid between March, 1896, and March, 1897, and in addition to these, 8½ miles of feeders were laid, of which nearly 4 miles had been laid during the year. The total length of single conductor amounted to no less than 167 miles. At the present time, further very large extensions are being rapidly pushed forward, notably along the Wilmslow Road to the city boundary at Fallowfield, along the Stockport Road, along Hyde Road and Clowes Street, along Oldham Road, and along Bury New Road and Cheetham Hill Road, and it is hoped that the supply of current will be available in a large portion of the districts named for next winter. In Albert Square, the present annual cost of lighting by gas is approximately £162, the illumination given being approximately 2,380 candle-power. The cost of electric lighting is estimated at £142, or, including interest on capital for lamps, mains, &c. and depreciation, £166, while the illumination afforded will be the equivalent of about 15,000 candle-power, or over six times as much as at present. In St. Ann's Square, the present cost of lighting by gas is about £45 for an illumination of about 660 candles, while the estimated cost of the electric lighting is £25, or, including depreciation, &c., £30, the illumination being the equivalent of 3,000 candles, or nearly five times as much as at present. In Piccadilly, the present cost of lighting by gas is approximately £174 per annum, and the illumination afforded is the equivalent of 2,730 candles, while the estimated cost of the electric lighting is £85, or, including interest and depreciation, £101, while the illumination is the equivalent of 9,000 candles, or considerably over three times as much as the gas.

Maidstone.—Mr. Barker has given notice that at the next meeting of the Town Council he will move that the Council carry out the electric lighting order themselves.

Norwich.—A Local Government Board inquiry was to be held yesterday as to the application of the Town Council for sanction to borrow £200 for the purposes of electric lighting.

Salford.—We understand that the Town Hall is to be lighted electrically, at an estimated cost of £850.

Stafford.—The annual report of the Gas and Electricity Committee states that the electric department for the year ended March 31st, 1897, has been very successful for a new undertaking; 48,168 units of electricity were sold during the year, yielding a revenue of £1,215 1s. 6d., an increase of £755 10s. 8d. The expenditure was £613 16s. 9d., leaving a gross profit on revenue account of £601 4s. 9d. Adding £296 11s. 6d., brought forward from the previous year, there was a balance of £897 16s. 3d., which has been carried forward. They would therefore not require any assistance from the Finance Committee to enable them to meet their obligations on loan account for the current year. The question of increasing the engineer's (Mr. Bell) remuneration is to be considered, on the recommendation of the Committee.

Taunton.—The electrical engineer (Mr. Harold W. Cousens) reports that during the past quarter they have connected up to the mains the equivalent of 300 8-C.P. lamps, and there is every probability that this satisfactory increase will be maintained during the ensuing quarter.

Torquay.—We understand that operations in connection with the erection of the electric lighting station buildings and the laying of mains have been commenced.

Wakefield.—A deputation has recently been paying periodical visits to Messrs. Fowler's works, to see how they are getting on with the electric light plant. It is expected that the Wakefield supply will be ready some time in August.

Whitehaven.—The Town Council has decided to increase the salary of Mr. Mayson, the electrician-in-charge, by £25 a year.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

A Sturdy Child.—Where is the non-progressive town councillor, or the elderly tramway director, who has not thought in his mind (and probably expressed the opinion openly) that "electricity is in its—;" but there we can't bring ourselves to repeat the nauseous formula. They not only said it in time past, on every possible occasion with respect to electric lighting—as to which the grudging admission is only now made that it is a desirable and profitable industry; but the same idiotic remark is dinned into one's ears in regard to electric traction, until the work of persuasive pioneering becomes loathsome, and one feels inclined to throw it up and "let *ill* alone." How long does it take an infant to grow up? Men are given, in law, 21 years lease of infancy, and sometimes (especially with numerous town councillors and elderly tramway directors) the term is prolonged, as a matter of fact, to twice or even thrice that period. A good deal depends, we suppose, on whether the individual indulges meantime in a Rip van Winkle sleep of ignorance or non-advancement, and that we suppose is what would be said in reply to the statement that electric cars were running and carrying passengers 57 years ago. Some of the younger generation can only go back 12 or 20 years to their first ride in a *bonâ fide* electric tramcar; but a worthy old Scotch gentlemen from British Columbia writes to the New York *Electrical World* some interesting reminiscences of Robert Davidson's early efforts in electric traction so far back as 1840. An infant 57 years old is, or ought to be, tolerably sturdy; and although its education and advancement may have been shockingly neglected (curiously enough, during the anti School Board days), no one can say, now, that it has not during the past 20 years made up for lost time, coming out easily at the top of the class. Anyway, it is full time that we were spared the senseless repetition of a parrot-like formula, and of such fossilised notions as are contained in the following remarks:—"The directors had observed that there was talk of electric traction in the air (!) and they would give all the necessary attention to improvements of that kind, so that, *if necessary*, they would be able to move with the times." Also:—"Much of the talk about electric traction was mere rumour. It was to be hoped that before anything of the kind was undertaken, the directors would be satisfied that it was a *paying matter!*" The italics, &c., in the above quotations are our own. These remarks were not made in the year following Davidson's experiments, but have been publicly uttered within the past two months in the present Jubilee Year of Grace in connection with one of our largest tramway systems. We can only say to the directors that the time for "giving attention to improvements of this kind" has gone by long ago. It is time, now, to give out orders for electric plant, by means of which:

"Lines shall pay that never paid before,
And those that paid shall now pay all the more."

Leeds.—The tramway workers on the Corporation lines have laid before the Highways Committee a communication setting forth the increases in wages which the Corporation is asked to concede. From a list published in the *Leeds Mercury*, it is apparent that the demand is general among all sections of the tramway employés, and the advances will represent a good round sum in the course of the year. We have no doubt the Corporation will do its best for its employés, but whether or not it will consider that the financial position of the undertaking warrants the additional expenditure remains to be seen.

Birmingham.—The Public Works Committee held a protracted conference with the representatives of the City of Birmingham Tramways Company, on 24th inst., with reference to the system of electric traction to be adopted. The Committee had in attendance for them Mr. Edward Pritchard, civil engineer, of Birmingham, and Dr. John Hopkinson. The Company is understood to have offered to lay down the conduit system instead of the trolley; if the length of the lease is doubled—*i.e.*, 42 years instead of 21 years—the cost of the conduit being such as would not allow them to recoup themselves in a shorter term.

Cheltenham.—A Government inquiry was held last week at Cheltenham into the application for a provisional order for constructing a light railway from Cheltenham to Cleeve. The Light Railway Commissioners were the Earl of Jersey, G.C.M.G., and Colonel Boughey, C.S.I., with Mr. Bret Ince (secretary). Public bodies were largely represented. Mr. Banks was present on behalf of the promoter (Mr. Nevins). Mr. Banks explained at length the proposal, which was originally to take the line through the town from the Midland Station on to Cleeve Hill and Winchcomb, a distance of 9 miles, but at present they could not ask for an order sanctioning the whole scheme, and therefore asked for an order to sanction part—to Cleeve only—the intention being to apply for an order to complete the scheme, by running round Cleeve Hill, at the earliest possible moment. The Cheltenham Town Council were strongly in favour of the scheme, and the County Council objected to the scheme being carried out in instalments. His Lordship said they could not sit upon the scheme as presented to them. After some further argument, his Lordship declined to adjourn, and Mr. Banks with much regret withdrew the application.

Cradley Heath.—The Rowley inhabitants met on 24th inst. to discuss whether they should oppose the scheme of the British Electric Traction Company, to construct a light railway or tramway from Old Hill to the Five Ways, Cradley Heath. A motion was carried declining to oppose the scheme.

Devonport.—The Tramways Committee report that they have considered the propriety of providing tramways for the borough, and the proposal meets with general favour. The Town Clerk suggested that the questions of electric light and tram traction should be considered concurrently. The Committee will go exhaustively into the matter.

Dover.—The delays of the contractor who is preparing the roadways for the electric tramways are causing the Corporation a good deal of displeasure, as well as upsetting the residents and tradespeople of some of the affected thoroughfares. The Mayor informed a deputation of Snargate Street ratepayers that the Corporation was thoroughly dissatisfied with the "disgracefully slow manner" in which the contractor was carrying out his work. In the Corporation discussion some strong remarks were made on the subject. It was hoped that the tramways would be in operation on July 7th. There does not appear to be much prospect of this hope being realised.

(*Continued on page 752.*)

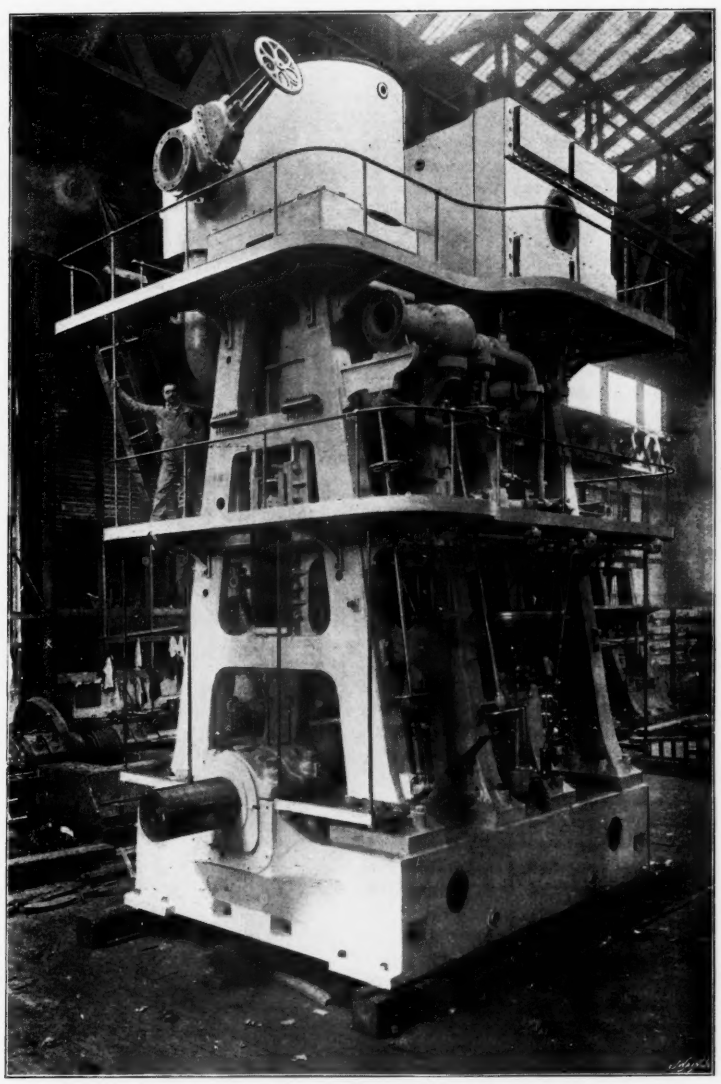
THE EDISON ELECTRIC ILLUMINATING COMPANY OF NEW YORK.

By HAROLD LOMAS and HERBERT C. GUNTON.

One of the most interesting developments of electric lighting is to be found in the history of the above-named company.

In May, 1881, some enterprising capitalists decided to introduce the electric light in New York. The result was the purchase of two buildings on Pearl Street, and the laying of underground tubing and house wiring was immediately begun; the installation of the tubing occupied the personal attention of Mr. Edison himself for some months. On September 4th, 1882, the Pearl Street station was regularly started with six "Jumbo" Edison steam dynamos of 125 H.P. each, direct coupled to Porter Allen engines, lighting during the first month 85 houses, wired for 2,323 lamps.

This undertaking was on the two-wire system, covering about a square mile of territory. Now there are six stations on the "three-wire" system, of which the most important is the Duane Street station which has taken the place of the old Pearl Street Central. At the end of 1896 they supplied 279,405 incandescent lamps, 3,225 arc lamps and motors to the extent of 15,930 H.P. the total equivalent in 16 candle-power lamps being 560,342. Besides this the Manhattan, Haarlem and Madison companies are consolidated with the Edison Company as a high tension division.



2,250 H.P. Vertical Quadruple Expansion Engine.

These companies had on their station service at the end of 1896, 29,964 incandescent, 2,334 arc lights, and 23 horse-power in motors, or an equivalent of 53,649 16-C.P. lamps, which added to the Edison station service gives a total of 613,991.

The gross station returns at the end of 1896 were $1,771,229, and the proportion of expenses to gross returns 47 per cent.

The city is divided into two districts, namely No. 1, the down town and business district, and No. 2, the "uptown" and residential district. Roughly speaking, 8th Street is the dividing line, and there are six low tension stations in all, namely Duane Street and the Bowling Green storage battery in the "down town district," and 12th Street, 26th Street, 39th Street, and 53rd Street stations in the "uptown district." These are also reinforced at times of maximum load by a transformer station at 72nd Street, which contains motor generators, the generators supplying direct current at 135 volts, and the motors being supplied from the alternating mains at 2,000 volts.

The Edison proper, or three-wire system extends a distance of 5½ miles, and this with the high tension additions amount to 8 miles.

Duane Street Station.

When this site was chosen to replace the old Pearl Street station, land was extremely valuable, hence to avoid large capital outlay in purchasing a large plot of land, the plan was carried out of placing the different sections of the plant on different floors, hence we have in this station the coal bunkers on the sixth floor, the coal being hoisted from the street by a bucket elevator driven by an electric motor and conveyed to the various bunkers by an overhead carrier, the fuel used is anthracite buckwheat, which is practically smokeless.

The boilers themselves are on the fourth floor, the coal chutes coming down through the fifth floor, which also contains the smoke flues which are eventually led to two gigantic stacks familiarly known as the heavenly twins.

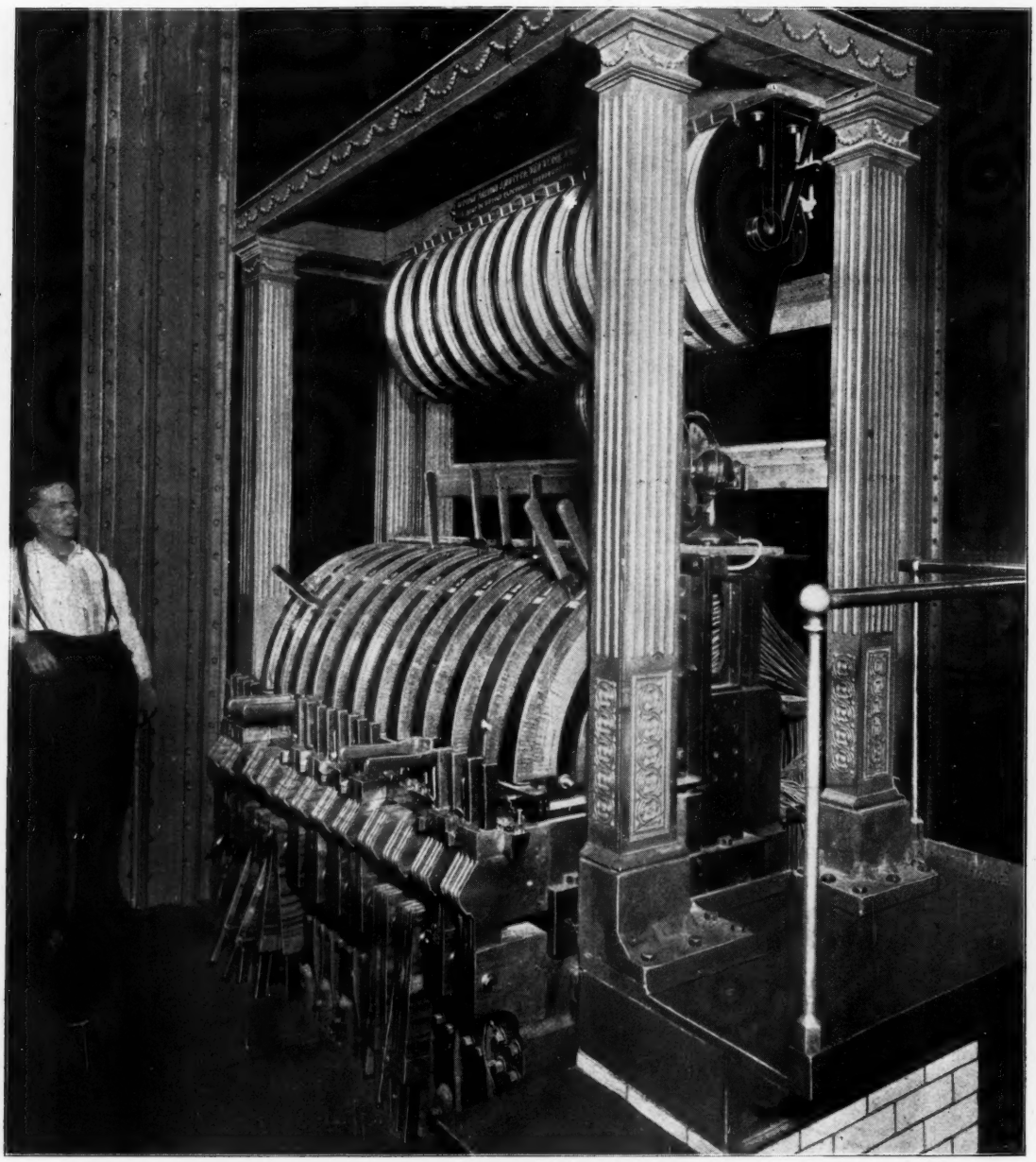
The steam plant at present consists of 11 Babcock-Wilcox boilers each of 375 nominal H.P. and designed for a working pressure of 210 lbs. They are running now at a pressure of 180 lbs., but it is contemplated to run them at 210 lbs. and also to condense when the load becomes heavier. This room runs the whole length of the building, and space is provided for 14 more boilers.

The floor beneath the boiler-room contains the feed-pump, fans and air ducts for the forced draught, ash tramways, &c. The engines are, of course, on the ground floor, the feed-water heaters being housed on the second floor, which is also used as a storeroom, all the necessary stores being systematically stocked.

Since the erection of this station in 1891, the company have made it their head-quarters, and large and commodious offices are provided on the top floor.

Passing on to the consideration of the plant in more detail, we find that in the engine room a very difficult problem was successfully grappled with. As originally

designed, it was decided to put down 13 600-H.P. engines. The low ratio of power to area became apparent, however, and on subsequent consideration it was determined to economise space by erecting engines of 1,250 H.P. Further thought showed that the most economical way would be to use quadruple expansion engines of the two crank type of 2,500 H.P. This was carried out with the result that there is room for plant to the extent of 28,000 H.P., which gives a H.P. to each half square foot of real estate, a result which, as regards economy of space, is unequalled. The manner in which these difficulties were overcome, and the novel form of engine design adopted is due to Mr. Van Vleck, the company's chief electrician and constructing engineer.



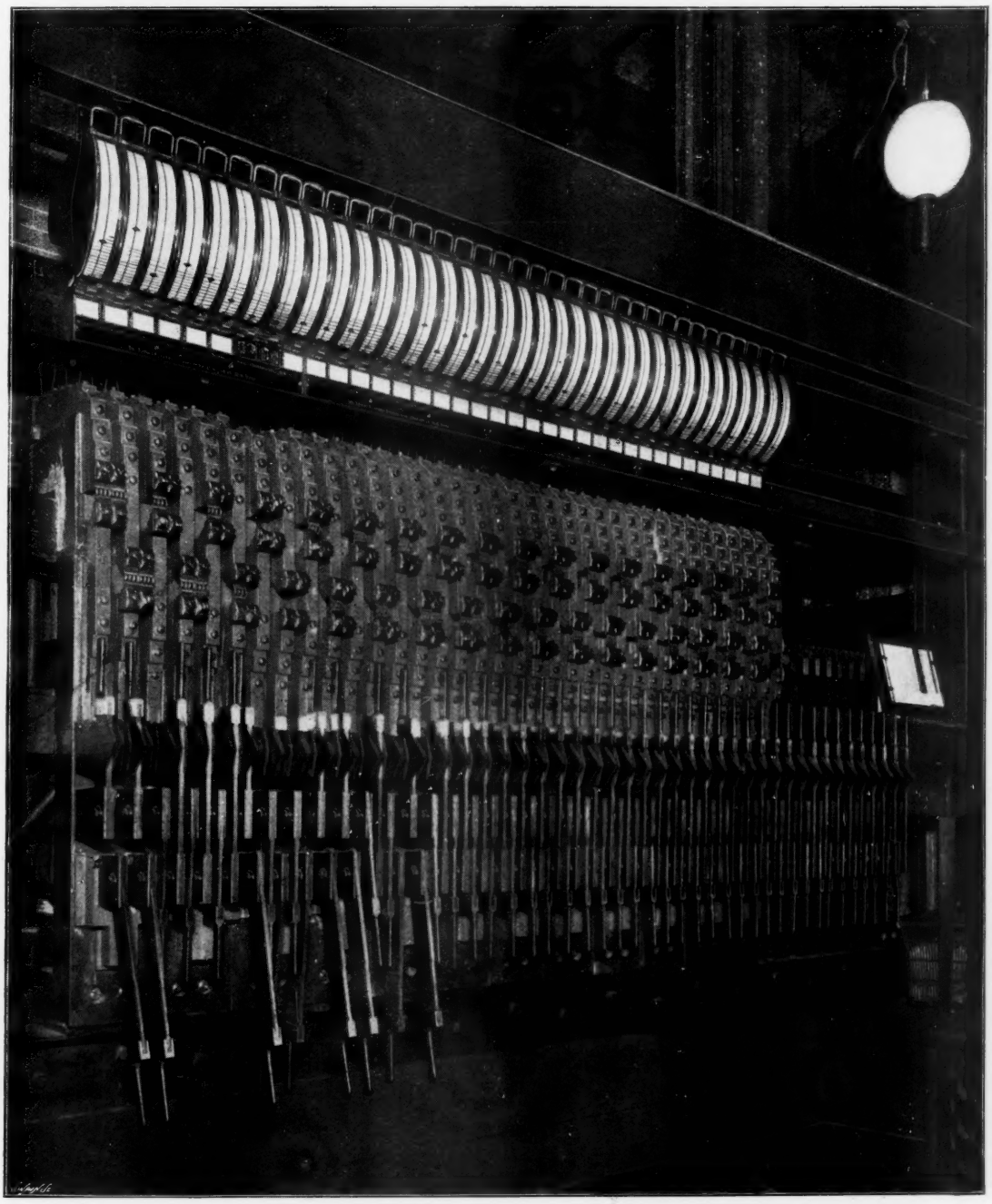
Duane Street Station Switchboard.

The operating room runs the whole length of the building, and the engines, all direct connected to General Electric dynamos, are arranged in two rows, one on each side of the room. It is 29 feet high, 65 feet wide and 160 feet long, and at present contains one two-crank quadruple expansion engine of 2,580 H.P., two 3-crank triple expansion of 1,250 H.P., and three 3-crank triple expansion of 600 H.P., all built by the Dickson Manufacturing Company of Scranton, Pa. A second 2,500 H.P. 2-crank quadruple expansion by the Southwark Foundry and Machine Company of Philadelphia, has lately been added, and there is room for eight more of these. A feature of the engines is, that they have their steam chests in front of the cylinders and not between them, and have radial valve gear instead of eccentrics, the result being that in length they only take up $\frac{2}{3}$rds of the space they otherwise would.

The quadruple expansion engines have the high pressure and second intermediate in tandem on one crank, and the first intermediate and low pressure cylinders in tandem on the other, the angle between the cranks is 90°, and the dimension of the Southwark engine cylinders are 29 inches, 38 inches, 54 inches, and 72 inches with a 39 inches stroke. This gives a very uniform crank effort, and is convenient for the steam pipe connections. The use of the quadruple expansion is not so much to gain the extra economy, as for the better power space ratio it gives, and for the reasons above stated.

The dynamos are all General Electric ring-wound multipolar shunt generators, the armature being wound such that

the winding itself forms the commutator. The brushes bear on the vertical face of the coils, the various sections of which are bared to make contact. The generators are carried on extensions of the shaft, one on each side of the engine to which they are coupled. One is connected to the positive and neutral, and the other to the neutral and negative. They consist of three sets of 200 kw., one of 400 kw., and two sets of 800 kw. Three wire feeders are used throughout, and in no case are the machines connected across the 'outside' wires, a practice which has found considerable favour in this country. The switchboard is a most unique piece of work, and was specially designed by Mr. Van Vleck, to meet the special features of the case. We cannot do better than insert Mr. Van Vleck's own account, which runs as follows :—



Duane Street Station Switchboard.

THE DUANE STREET STATION SWITCHBOARD OF THE EDISON ELECTRIC ILLUMINATING COMPANY, OF NEW YORK.

"As regards the electrical controlling apparatus at the Duane Street station of the Edison Electric Illuminating Company of New York, which is the largest station in New York, if not in the country, I will call your attention to certain features embodied in its construction, which, I believe, when better understood and appreciated by electrical engineers, will become pretty generally adopted in the construction of station switch or controlling boards, on account of the very great reduction in the space occupied by the apparatus in question over the older methods, and on account of several very important operating advantages which the system possesses.

"The switchboard occupies the central portion of the operating room, where the room would be unavailable for electric generators on account of the piers supporting the two main smoke stacks, which gave a space for switchboard purposes just 40 feet in length, and, in designing the switchboard, the problem was to place dynamo and feeder controlling apparatus for a possible maximum current output of 160,000 to 175,000 amperes at 120 to 140 volts, to be generated from 28 multipolar dynamos distributing to 65 or 70 feeders.

"As this limited switchboard space at disposal, was even less than the space sometimes required for the regulation of a comparatively small isolated plant, or central station of a few horse-power, the problem of constructing a board for nearly 30,000 H.P. in so small a space was a serious one, as any encroachment or overlapping of the electrical apparatus into the space allotted for engines and dynamos would easily have sacrificed several hundred horse-power of generating machinery.

"The fact that the entire apparatus required for regulating a feeder, could be made to occupy a space 3 inches wide, and that the entire apparatus required for the control of a 800 kilowatt dynamo could be made to occupy a space 6 inches wide was established by the writer as a possible attainment in the fall of 1890, which idea has since not been departed from in the construction of the switchboard in question, although, at first, it did not appear at all clear to the writer or to others, as to how the problem was to be solved.

"Finally, however, what has been appropriately called the Edgewise system of electrical apparatus was developed to meet the requirements of the case, which, as a system, is nothing more than the placing of the registering and controlling mechanism on their edges, side by side, as books on a shelf, instead of placing them face front like a row of clocks.

"Thus, for instance, a row of ampere meters required for both poles of the 70 feeders laid out for this station, if placed 'flat ways,' would extend for a distance of 150 feet; whereas by modifying their design and placing them edgewise less than 40 feet would be required.

"The advantages of this system were at once appreciated, but its actual employment was beset with difficulties, in that no apparatus before developed was suitable for being placed in this novel manner.

"The first work done was the development of a feeder switch of 1,500 amperes capacity, which switch was 3 inches wide, and which permitted the feeder to be supplied from either one of two bus bars. A dynamo switch, 6 inches in width, was also developed which had a capacity of 8,000 amperes. At the same time, experiments were made with direct current ampere meters, placed edgewise, in which the entire current to be registered passed through the instrument, but it became apparent that direct current instruments of this type were both cumbersome and expensive, and also that the resistance caused by their insertion into the circuits entailed an expensive loss of energy.

"Mr. Edward Weston then became interested in the matter and proposed his well-known shunt ampere meters, which type of instrument was found to be especially well adapted for the requirements in question, and as a result, the line of edgewise ampere and volt indicators, as now manufactured by the Weston Electrical Instrument Company, were then developed so that the working out of the other details of the controlling apparatus was an easy matter.

"The controlling platform was elevated about 4 feet from the floor of the operating room, and it is reached by a stairway at either side of the dynamo apparatus which is at the front of the platform overlooking the operating room, enabling the dynamo controller to face his machinery. The apparatus for the control of each dynamo consists first of a large main switch, in the neutral conductor from each dynamo, which switch serves also as a structure for the support of a quadrant-shaped rheostat switch, which throws in, or out, the resistance of the field circuit. The quadrant consists of a slate base placed edgewise with a commutator on the side connecting, by means of wires, to resistances placed below. The resistance is varied by moving up, and down, a lever carrying a contact bearing on the commutator; the lever being raised, when the dynamo load is to be increased, and lowered when the load is to be decreased. In this way the mechanism for switching and regulating a dynamo (up to 8,000 amperes capacity) was compressed into a width of six inches, facing the operator.

"Above each dynamo controlling section, is a large Weston edgewise ampere meter especially developed for the New York stations, each instrument corresponding in width to the dynamo controlling apparatus below.

"The main station volt indicators, by which the regulating of the system is done, are placed below the dynamo ampere meters, directly in front of the operator, all of which, results in an arrangement of indicating apparatus that is so compact that the operator can see at a glance the relative ampere outputs of each machine and the accuracy of his district pressure, as nothing is so natural and easy to comprehend as the movement of the several indicating pointers, in an up and down direction on the dials of a line of instruments placed side by side. Should the operator desire to increase the load on any machine, or to raise the E.M.F. on the system, he has simply to raise the quadrant handle of the particular machine, or to raise a number of handles in case the system E.M.F. is to be elevated.

"This is considered by the writer, and by many others who have seen the system, as the simplest, most natural, and most satisfactory method of controlling electrical machinery, reducing to a minimum any chance of making a mistake which might interfere with the well running of the plant. All of this dynamo apparatus is, therefore, as explained, bunched together into a kind of controlling pulpit which overlooks the dynamo and engine room, while the feeder switchboard is placed at the rear of the operator on the face of the main piers supporting the stacks.

"As regards the feeder portion of the switchboard, each feeder is provided with the following equipment, which is all placed in a space 3 inches in width. At the bottom of each section the current starts from either one of two 'busses' through a narrow double feeder switch—one switch for each bus; above the two switches are separable safety catch holders, bolted on the main conducting coppers, above which the current is carried to the rear, and away to the street conductors. Directly above the switching apparatus is first placed the row of feeder ampere meters, and again above is placed the row of feeder volt indicators, each instrument over its respective switch, all of which instruments are constructed on the edgewise plan as perfected by Mr. Weston.

"The placing of these instruments in a row on a switchboard brings into play a very pretty and desirable function, in that, the black needles or pointers on the white dials of the ampere meters and volt meters form on the face of the board a curve presenting first the amount of the current sent out to the several portions of the system; and second, a curve or line showing the distribution of the pressure throughout the system, which is effected merely by placing the feeder sections in the order which they supply the system with energy.

"Thus, for instance, if the load in the down-town part of the district happens to be high while the load in the uptown portion is low, the down-town part of the row of ampere meters will show the curve running high, while the uptown portion of the row, will show the curve running low.

"The volt meters in the same way will show a low curve in the part where the pressure is low, and a high curve in the part where the pressure is high, thus if the pressure is constant or even throughout the district, as it ought to be, the volt meter pointers will indicate a straight black line across the face of the switchboard.

"In this the station operator, superintendent or manager can see at once, the conditions existing as regards the general station load and pressure of the district, and at a glance, any defect in district pressure can be observed and located.

"In the rear, again, of the feeder switchboard is placed a dynamo switchboard connecting the outside poles of all the dynamos to the main station bus bars; the dynamo switches on this board are so arranged that by reversing the field of any dynamo, and making the proper connection, the machine can be thrown over on the opposite side of the three-wire system.

"In addition to the outside pole dynamo switches, each dynamo is also provided with a special outside pole switch, placed directly on the dynamo frame, to be used in case of emergency—when the operator might fail in time to throw a dynamo out of circuit in case of an accident.

"The main positive and negative 'bus bars' are each composed of two massive copper bars, 14 inches wide and 1 inch thick, so mounted that additional bars can be added without disarranging any of the bus-bar connections, these large bars being much easier mounted and connected than a bundle of small bars, as commonly employed.

"The 'neutral bus' is constructed in two branches, all the positive machines being connected to one branch, and all the negative machines to the other; which will, by the

employment of the shunt ampere meter, enable all the current generated in the station to be measured on the positive and negative sides of the system.

"The fields of all the dynamos are charged by means of the Donshea Field charging system, which permits the field of a dynamo to be excited directly from the bus, on starting up, while in shutting down, the pulling out of the 'neutral dynamo switch' automatically causes the field to be self-excited and to die out as the machine is slowed down, thus doing away with the disadvantage of the serious arcing which occurs when a bus excited field is broken suddenly—even through a resistance, the advantage of such a system being very great, compared with the old practice of either 'bus' or 'self-excitation.'

"Each field, in addition, is supplied with a switch connected to the 'outside pole switch' of its dynamo, which permits the field, in starting up, to be charged either from the bus or from an outside source such as another dynamo run for the purpose. This being necessary in the case of starting up the station after a general breakdown when no current would be on the outside 'busses.'

"In conclusion, it may be unnecessary to state, that the entire equipment is built of fire-proof material, and in order to render even the cable and various wires as incombustible as possible, all the insulated cable is covered with a lead or asbestos protection. The switches, with few exceptions, are constructed of pure copper, either cast or wrought, as is now the latest practice."

A very careful record of the load is kept, the time of throwing in or out any machine, and the load while running, together with the bus bar voltage being carefully noted.

Piping, &c.

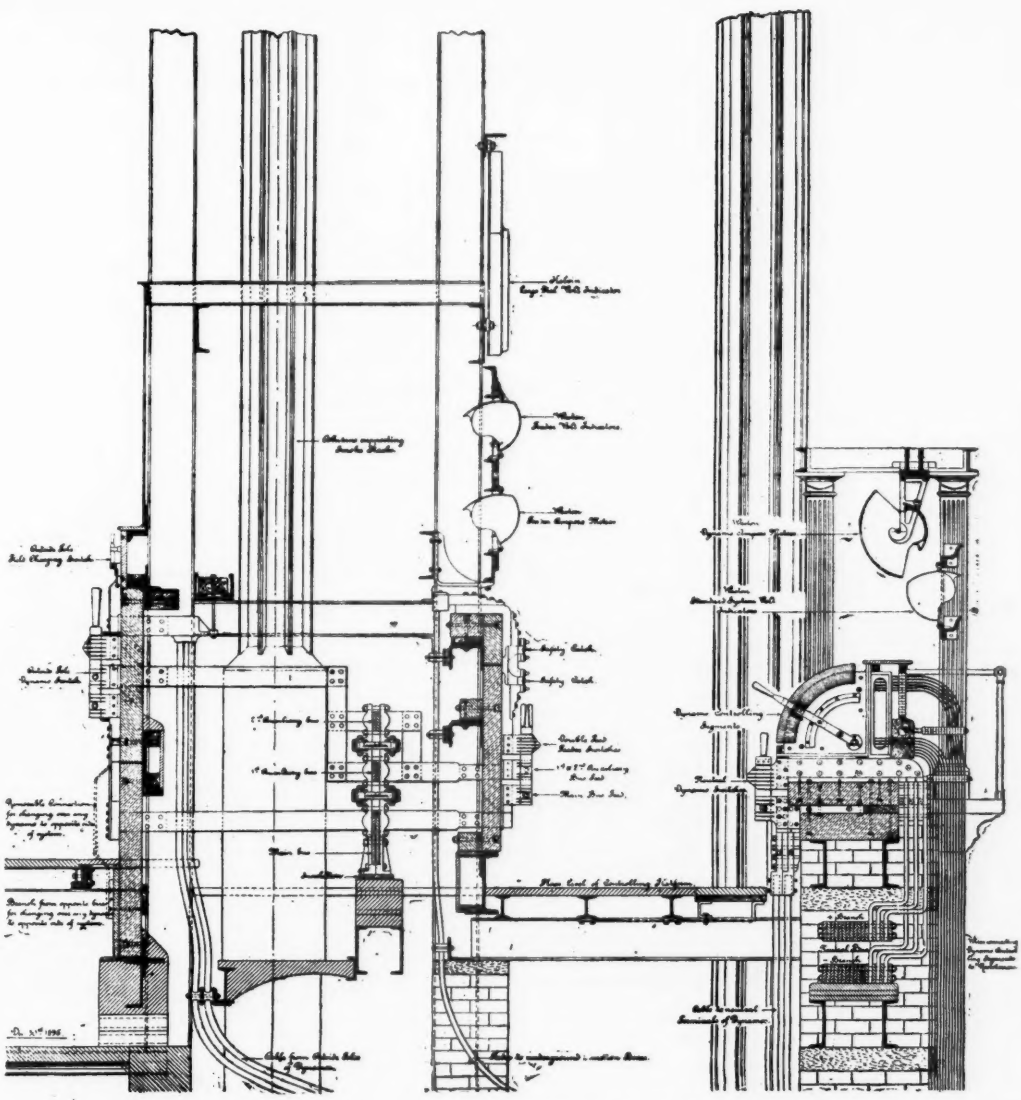
The engines are all fed from one cast-iron main. This is made of extraordinary strength, first to obviate the use of duplicate piping, and second, to provide against the unusually high pressure. The diameter is 14 inches, thickness 1½ inches, and thickness of flanges 5 inches, all joints are ground, a method which has given highly satisfactory results.

To provide for expansion the leads to the engine are of copper wrapped with steel bands.

The main is fed from the boiler room by three vertical pipes, each of which is provided with a separator, as also is each engine.

The exhaust pipes are at present arranged so that each passes through one of four feedwater heaters, and eventually exhaust through the roof by means of three 32-inch exhaust risers.

This, the Duane Street station, is the largest and most modern of all the stations, and can take charge of the whole down town district, it is, however, hoped by means of



Sectional Side View of Dynamo and Feeder Controlling Apparatus as Installed at the Duane Street Station.

Classified Index of Operating, Construction and Ledger Accounts.

A Lower Dist.	B Both Dist.	C Upper Dist.	D Duane St.	E Produce Ex.	F 12th St.	G 26th St.	H 39th St.	I 53rd St.	M Manhattan.
OPERATING.						CONSTRUCTION.		LEDGER ACCOUNTS.	
General Expense Office. 0.	General Technical. 1.	Production. 2.	Repairs. 3.	Distributing Maintenance. 4.	Distributing Repairs. 5.	Construction Stations. 6.	Construction. Districts. 7.	Supplies. 8.	Miscellaneous. 9.
00 Sundries. 1 *Rentals.* 2 *Lighting & Heating.* 3 *Meals.* 4 *Car fares.* 5 *Janitors' Supplies.* 6 *Ice.* 7 *Interest, &c.* 8 *Bond and Stock Expenses.* 9 *Undistributed freight.*	10 Meter [Sundries	20 Sundries [Ex. 1 *Rentals.* 2 *Lighting and Heating.* 3 *Meals.* 4 *Car Fares.* 5 *Post Tel. &c.* 6 *Ice.*	30 Sundries. 9 *Furniture & Fixtures.*	40 Sundries.	50 Sundries.	60 Sundries.	70 Sundries. 7 *Laboratory Apparatus.* 8 9 *Tools and Implements.*	80 Sundries.	90 Sundries.
01 Executive. 1 *Directors.* 2 *P.V.P. S. & T.* 3 *Assistant General Manager.*	11 Meter [Labour. *(Maintenance.)*	21 Superinten- [dence & care. 1 *G.O. Supt.* 2 *Dist. Supts.* 3 *Assist. Supts.* 4 *Clerks and Office Boys.* 5 *Janitors, &c.*	31 Salaries and [wages. *(Undistributed.)*	41 Salaries and [wages. 1 *Junct. Boxes.* 2 *Annual Survey.* 3 *Service Ends.* 4 *Watching Openings.*	51	61 Salaries and Wages. *(Undistributed.)*	71 Salaries and Wages. *Undistributed.*	81	91 Labor. *Outside Parties.*
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06 Insurance. 1 *Fire.* 2 *Boiler.* 3 *Elevators.* 4 *Glass.* 5 *Casualty.* 6 *Fidelity.* 7 *Income.* 8 *Reserve.*	16 Inspection [Exp.	26 Fuel. 1 *Coal.* 2 *Wood.* 3 *Oil.* 4 *Gas.* 5 *Steam.* 6 *Removal Ashes.*	36 Dynamos. *Including Labor.*	46	56 Boosters.	66 Dynamos.	76 Boosters.		96 Motor Inspection.
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09 Furniture and Fixtures. 1 *Office Furniture.* 2 *Partitions and Flooring.* 3 *Vaults and Safes.* 4 *Office Wiring.* 5 *Telephones.* 6 *Telemeters.* 7 *Steam Heating.*	19	29	39 Station tools and Impts.	49 Exterior Tools & Impts.	59 House Instal 1 2 *Service Wiring.* 3 *Converters.* 4 5 *Interior Wiring.*	69 Furniture & Fixtures. 1 *Office Furniture.* 2 *Partitions & Flooring.* 3 *Vaults and Safes.* 4 *Office Wiring.* 5 *Telephones.* 6 *Telemeters.* 7 *Steam Heating.*	79 House Instal 1 2 *Service Wiring.* 3 *Converters.* 4 *Motors.* 5 *Interior Wiring.*		99 Removal Accounts.

the Bowling Green battery station, recently installed in this district, to entirely shut down the Duane Street station at times of minimum load. This battery is fed from Duane Street by four feeders, which are fitted with the Bowker Van Vleck controlling disconnective device, which consists of a switch operated by a motor controlled from the central station, and permits of a feeder being either connected into the network or used as a tie feeder.

This device is in general operation throughout the system, and a great saving of copper is thereby effected. The battery consists of 75 cells of the Electric Storage Battery Company, of Philadelphia, each cell containing 14 "Manchester" and 15 chloride plates, the cells being 20½ inches by 30½ inches by 40¾ inches deep. They are guaranteed to give 2,000 amps. per side for 1 hour, 1,000 amps. for 3 hours, and 400 amps. for 10 hours, the normal rate being 400.

The charging is effected by means of a boosting arrangement, which consists of four machines all coupled together, the two generators being on the outsides with the motors between them. This arrangement permits of the generators being driven by one or both of the motors. The dynamos are designed to boost 1,200 amps. 60 volts, and the motors are compound-wound.

The regulating switches are four in number, two to each side, thus permitting of a discharge at two potentials.

The "Uptown" District.

The "uptown" stations have suffered to some extent by having old plant from down town transferred to them, and some or all are in a state of development. 26th Street is the largest, and is run at its full capacity; 12th, 39th, and 53rd Street stations are run for various times, according to the station and season.

All these three latter have storage batteries. The 12th Street station has lately laid down some modern plant in the shape of a 300 H.P. De Laval steam turbine; it runs at 9,000 revs., and drives by a helical gearing two Desrosiers dynamos, which are side by side both driven off the same pinion.

The results of tests show a consumption of 17¾ lbs. of water per E.H.P. at full load, and of 18 lbs. per E.H.P. at half load.

Instead of the worm gearing usually employed, the Edison Company preferred to use a helical gearing, the pinion engaging with two sets of double helical wheels, the teeth being cut in a phosphor bronze rim, fixed to a steel spider. The reduction is 7 to 1, and there is little friction or noise.

Another interesting feature at the station is the Barnard cooling tower, an arrangement for cooling the condensing water. This is pumped to the top of the tower and runs down 42 mats, 11 inches by 12 inches, suspended vertically, ½ inch apart. Each mat is made of a triple mesh of iron wire, air being forced up through them by a fan driven by a 17 H.P. motor. At full load, 800 H.P., this will keep the condensing water at an initial temperature of 80° with a final temperature of 130°. The amount evaporated, however, amounts to 3 per cent. of the whole.

All these stations are connected together by tie feeders fitted with the Bowker Van Vleck system above mentioned, and besides this the feeders from all the different stations feed into the network so that no consumer is dependent on any one feeder or station.

The "peak" comes on "down town" between 4 p.m. and 5 p.m. and up town about the same time. There is, however, another and smaller peak "up town" about 8 p.m. The system of tie feeders enables the different stations to aid each other in the different districts according to demand. The voltage across the outside wires in New York is 240 and across the inner 120; the mains are entirely underground and for the most part laid in Edison tubes. This method consists in drawing the three mains insulated with jute through iron piping cast in lengths of 20 feet, and then forcing an insulating compound into the tube which completely insulates the mains from each other and the pipe. Arrived at the customer's house, the current passes through a meter, the instrument in use being the Edison chemical meter. This is very simple and consists of two zinc plates immersed in a standard solution of zinc sulphate, a definite portion of the current being shunted through the meter. The increase in weight of the "gaining" plate furnishing the record of the consumption the plates being periodically collected and replaced. A whole department is devoted to the weighing, registering, and refitting the meters, the work being carried out with all possible accuracy.

As regards cost to the consumer, the price charged in incandescent lighting is 1 cent per hour for each 16 candle-power lamp (approximately 50 watts at the meter), or about 10d. per B. of T. unit, this is subject to discount ranging from 5 per cent. for monthly bill between £20 and £40, up to 50 per cent. for bill of £600 and upwards; an additional discount for bills exceeding £40 is allowed, based on the lamp hours per month per 16 C.P. lamp, or equivalent installed, this ranges from 5 per cent. for 50 lamp hours per month per lamp, to 20 per cent. for 125 lamp hours and over. A maximum total discount is fixed at 60 per cent., so that the minimum charge is 4d. per B. of T. unit; it is understood that a minimum monthly charge of 6s. for each separate month shall be paid.

In arc lighting the charge is 10 cents per hour for each standard lamp, viz., 8 amperes 60 volts, or about 10½d. per B. of T. unit, the discount, based on the lamp hours per month, ranges from 10 per cent. for a 100 lamp hours up to 35 per cent.; or for monthly bills of over £40 from 15 per cent. to 50 per cent., an additional 10 per cent. being allowed if the consumer provides and looks after the lamps. A minimum charge of 12s. 6d. per month per lamp is made.

Motors are charged for at 10 cents per H.P. hour, or 6½d. per B. of T. unit, the discount ranging from 20 per cent. for a 100 H.P. hour per month to 50 per cent. for 500 H.P. hours, and upwards, per month, a minimum charge of 12s. 6d. being made each month for each motor installed.

In making comparisons with English practice, it must be remembered that the Edison Company provide, test and maintain, all lamps, both arc and incandescent.

The report for 1896 shows a satisfactory increase in customers. An additional 48 junction boxes were laid down, making a grand total of 1,208, the number of service connections added being 719. The grand total of mains and feeders now laid down is 209·33 miles.

It will be readily understood that in such a large system as this the statistical department has a big task in keeping a record of receipts and expenditure. The accompanying tabular form shows how this is carried out. By this so-called "decimal" system, not, we believe, generally known to English engineers, what otherwise might be a very complicated piece of work is reduced to the greatest simplicity, a complete knowledge of the performances of the various stations being always at hand, without which economical working would be impossible. Thus D 323 refers to the repair of boiler tubes at Duane Street.

The prefixed letter determines the station or district, the first figure the vertical column, the second figure the section of that column, and the third the sub-division of that section. In addition, the heads of the various departments meet once a week and discuss the working results of the various sections.

Before we close this article, we must express our sincere thanks to Mr. Bowker, vice-president, Mr. Lieb, general manager, Mr. Van Vleck, electrician, and Mr. Winchester, for the time they devoted to us and for the information placed at our disposal.

Motor Cars Killing Time.—We have many a time heard of a man taking a bull by the horns, and crowding two days' work into one, but never before have we heard of a man crowding 50 hours into 24. We suppose to do this you have to take time by the fore-lock. Perhaps a young and tender daily paper, devoted to contract news, will enlighten us, for we observe in notifying the forthcoming *Engineer* motor car competition, it says that "*on the day of the race*, June 1st, 50 motor cars are to proceed to Birmingham and back within 50 hours," after which the prizes will be distributed at the Crystal Palace. That motor cars can kill people we have had ample evidence, but for them to kill time is new. We have always found them halting for a time, and a good long time at that. But, seriously, we trust and believe that next Tuesday's trial will possess a little more dignity than did the November absurdity. As it is under the control of the *Engineer*, we have not much fear on that score. If the November farce is repeated, the harm to the motor car business will be almost irreparable.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

(*Continued from page* 744.)

Dublin.—The Bills promoted by the Dublin United Tramways Company, under which powers are taken to make new lines and to use electric traction in the city and suburbs of Dublin, passed the House of Lords Committee on 19th inst. The Corporation the same day sanctioned the agreement between the Corporation and the Tramway Company with regard to the new tram lines and adoption of electrical traction in the city. Sir Robert Sexton stated that the principal thing in the agreement was that the company got a lease for 40 years of the existing and contemplated lines, and were to pay the Corporation £500 per year per street used, and not less than £10,000 per annum.

Dutch East Indies.—The Union Electrical Company, of Berlin, has secured a contract for the construction of about 15½ kilometres of electric tramways at Batavia.

Norwich.—The Norfolk County Council and the frontagers on Thorpe Road have withdrawn their opposition to the Norwich Electric Tramways Bill.

The Underground Electric Schemes.—A Select Committee of the House of Commons had the Earl's Court to Mansion House electric railway scheme under consideration on 20th inst. Mr. J. S. Forbes, the general manager of the District Railway, giving evidence said that this new line is merely an extension of the existing line. Before any conditions as to workmen's trains were imposed, it would only be fair that the electric railways should be given a fair trial. It was proposed in the Bill to empower the company to work their present line by electricity. Experts had said it was perfectly practicable to work the existing line by electricity. They proposed to apply it, in the first instance, to what was known as the Inner Circle. His company were asking for power to raise £500,000 for this purpose, and the Metropolitan Company would furnish a little more than that because their part of the line was a little longer. After discussion it was decided to leave the words "steam power" in the Bill as an alternative motive power to electricity.

Lord Morley's Committee of the House of Lords on the same day passed a Bill granting to the Charing Cross, Euston, and Hampstead Railway Company an extension of time for three years from August next within which to construct this underground railway as authorised in 1893. The Bill also empowers the company to expend £85,000 of its capital in the payment of interest during the construction of the railway. This Bill has now been sanctioned by both Houses.

The Streets Committee at the fortnightly meeting of the Commission of Sewers on Tuesday submitted a report with regard to the plans for the station of the City and South London Railway Company in Lombard Street, and recommending that no objection be offered thereto, subject to the construction of a low level subway connecting with the low level station of the Central London Railway in front of the Royal Exchange. This recommendation was adopted. Approval was also given to plans and sections submitted by the same company, showing the works proposed to be carried out beneath the public ways of the City, between London Bridge and the City boundary at Finsbury Pavement.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
West Indies—		
Puerto Plata-Martinique	Dec. 19th, 1895 ...	...
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Jamaica-Colon	Feb. 6th, 1897 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Konakry-Sierra Leone ...	April 28th, 1897 ...	May 24th, 1897.
Para-Maranham	May 5th, 1897 ...	...
Assab-Massowah	May 21st, 1897 ...	...
Landlines.		
Trans-Continental line beyond Mazol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Moulmein-Bangkok	May 5th, 1897 ...	...
Saigon-Bangkok	May 20th, 1897 ...	May 21st, 1897.
Saigon-Bangkak	May 24th, 1897 ...	May 25th, 1897.

April 19th, 1897.—Chio-Syra route impracticable.

April 19th, 1897.—During war between Turkey and Greece, cable between Trieste and Corfu cannot be used for messages for Turkey; they must be sent *vid* Bosnia, Montenegro and Servia.

The Ottoman Government announces that messages in secret language may not be sent to the Greek Minister and Consul in Turkey. They are to be in plain language.

April 21st, 1897.—The Greek Administration prohibits secret language for private telegrams for Greece.

April 25th, 1897.—The Hellenic administration notifies delay on press messages emanating from Greek provinces by reason of the lines being blocked.

May 21st, 1897.—During the interruption of the Assab-Massowah cable, telegrams between these places are sent by boat.

Glasgow Telephones.—The Glasgow Corporation have refused the inquiry which the Post Office offered in connection with the application they made for a telephone license.

Telephone Exchanges.—In the House of Commons last Friday, on the motion of Mr. Provand, a return was ordered giving the names of all telephone exchanges which the Post Office has at any time opened in the United Kingdom, with the date of opening, the number of subscribers at opening, the date on which each exchange had the largest number of subscribers, and their number, the dates on which exchanges now without subscribers became so, and the number of subscribers at the present date on exchanges still open.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bedford.—June 8th. The Urban Sanitary Authority want tenders for the supply and erection at the sewage pumping works of two alternating current motors coupled direct to two vertical spindle centrifugal pumps.

Belfast.—June 3rd. The Electric Committee want tenders for the supply and erection of switchboard, instruments and connections, also a motor-generator and boosters.

Belgium.—July 2nd. Tenders are being invited until July 2nd next, by the Municipal Authorities of Ghent, for the establishment of an electric tramway in the town. Particulars may be had from the Secretariat, while tenders are to be sent to Le Collège Echivinal, Ghent.

Bray.—June 7th. The Township Commissioners want tenders for the supply of electrical and other stores, including carbons, cables, switches, lamps, holders, fuses, &c., during twelve months. Particulars from the Town Clerk (Mr. P. MacDonnell), at the Town Hall.

Brazil.—June 30th. Tenders are being invited until June 30th next by the Municipal Authorities of Rio de Janeiro for the establishment of a telephone exchange in the city. Particulars of the contract were published in *Daily Tenders and Contracts* for May 6th.

Chili.—June 19th. The General Direction of the Chilian Telegraphs in Santiago is inviting tenders for the supply of a quantity of galvanised iron wire, insulators, Morse telegraph apparatus, &c.

Huddersfield.—June 1st. The Electric Lighting Committee are inviting tenders for the supply and erection of two steam boilers for the electric light station. Borough Electrical Engineer, Mr. A. B. Mountain.

Roumania.—August 20th. Tenders are being invited by the General Direction of the Roumanian Posts and Telegraphs in Bucharest for the supply of 55,000 porcelain (double-bell) insulators. Tenders to be directed to the Direction Générale des Postes et des Telegraphes, Bucharest.

Southampton.—June 16th. The Corporation wants tenders for the supply and erection of water-tube boilers, mechanical stokers, coal conveyor, pump, steam and water mains, water tank, water purifier, fuel economiser, and ironwork. Engineers, Messrs. Kincaid, Waller & Manville. See our "Official Notices."

Spain.—June 8th. The Spanish Ministry of Public Works in Madrid is inviting tenders for the concession for a projected electric tramway between Barcelona and its suburbs. Tenders to the Direccion Generale des Obras Publicas, Madrid.

Sweden.—June 8th. Tenders are being invited by the Stockholm Gas Works Authorities for the supply and erection of a 500 H.P. triple-expansion engine required in connection with the central electric lighting station. Tenders to be addressed to the chief engineer, Herr Ad. Ahlsell, Stockholm Gaswerk, Stockholm.

Wakefield.—June 2nd. The Wakefield Board of Guardians want tenders for the following work for the new infirmary:—1. Electric lighting plant, combined steam engine and dynamo, belt-driven dynamo, motor dynamo, motor, switchboards, storage cells, &c.; 2. Complete system of wiring for the electric light, also bells and telephones; 3. Vertical steam engine, feed water heater, tank, pumps and pipe work, &c. Particulars from Messrs. Shepherd & Watney, engineers, 71, Albion Street, Leeds.

CLOSED.

Blackburn.—Messrs. Russell Wright & Co. have secured the contract for a complete system of electrical fire alarms to be installed at the Blackburn Union.

Kensington.—The Vestry have accepted the tender of Messrs. Grist & Co. for telephone wires and instruments, to place their various depôts in telephonic communication with the Town Hall.

NOTES.

The Aberdeen Switches.—Mr. Alfred Blackman, the City Electrical Engineer at Aberdeen, writes as follows:—With reference to your paragraph in last week's ELECTRICAL REVIEW regarding tenders for battery switches for these works, the following is the first clause of the specification referred to by Messrs. Verity when they say "the specification was for one main battery switch, for which we quoted, but the quantity to be supplied was two switches." "The Corporation of Aberdeen are prepared to receive tenders for the supply and delivery of the following switch gear at the electricity works, Cotton Street, in accordance with the attached general conditions of contract. Under this contract *two* concentric battery regulating switches are to be supplied, but not erected. The *switches* are to be of the concentric type, the 'charge' portion of the switch being the inside, and the 'discharge' portion on the outside. The working bearings of the switch are to carry no current." I think that it will be clear to everyone that the mistake is theirs and not ours.

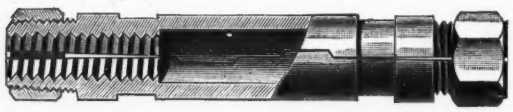
Lecture.—Mr. W. H. Preece, C.B., F.R.S., is to lecture at the Middleton Hall, N., on June 10th, at 8 p.m., on "Telegraphy without Wires." The lecture is in aid of the Islington Wesleyan Circuit Bazaar.

Lord Kelvin's Royal Institution Lecture.—At the Royal Institution last Friday evening, Lord Kelvin delivered a discourse on the "Contact Electricity of Metals." His Lordship began by performing an old experiment of Volta's, which he himself had introduced at Glasgow University some 50 years ago, and which was not described in the text-books, so far as he was aware. He showed, says the *Times* report, by means of an electrometer that when a zinc plate and a copper plate were brought into contact with one another and then separated, one was charged with positive electricity and the other with negative. It was tiresome to think of the nonsense that had been written about contact electricity simply through the absurd way in which Volta's work had been ignored. Attempts were made to explain away this experiment as being due to chemical action, and it was said to be the result of the oxidation of the zinc by moisture. The lecturer proceeded to prove that this explanation would not hold, by putting a little water on the zinc and copper plates, and showing that if the last contact between them was water the electrometer gave no deflection whatever, though if the last contact was metal an effect was produced. Another modern explanation of the electrification noticed by Volta attributed it to the action of the air. But experiments showed that air was a disturber and diminisher of the effect; the less air there was the better, and no air at all would be best. Volta, therefore, was absolutely right, in spite of the extraordinary wrong statements of the books. Lord Kelvin exhibited several other experiments illustrating electrification produced by means of dissimilar metals, and showed some curious properties possessed by uranium. If a plate of this metal was appropriately connected to the electrometer and touched by a plate of aluminium, positive electrification was produced, gradually changing past zero to negative. The radiation given off by uranium, as discovered by Becquerel, was also spoken of, and some photographs of coins, &c., were thrown on the screen which had been taken by its agency. These uranium rays were very feeble, an exposure of some 12 hours being necessary for photographic effects, but they were a constant property of the substance and were manifested in conditions which precluded the possibility of them being merely the slow radiation of previously absorbed light. He could suggest no explanation of the mystery. In conclusion he made some observations on the dimensions of the structure of matter based on deductions from the contact electricity of metals and the determination of the heat of combination of copper and zinc. He also begged physicists not to disregard Volta but to take his work seriously, and expressed disapproval of the method of teaching electricity generally pursued by beginning with the phenomena of electro-magnetism instead of with the older facts of positive and negative electricities.

Chartered Institute of Patent Agents.—Mr. W. Lloyd Wise, President of the Chartered Institute of Patent Agents, and Mrs. Lloyd Wise, held a reception last Friday, May 21st, at the Royal Institute of Painters in Water Colours, the following being among those who accepted invitations:—Prof. C. V. Boys, F.R.S., and Mrs. Boys; Mr. W. R. Bousfield, Q.C., M.P., and Mrs. Bousfield; Sir Courteney Boyle, K.C.B.; Mr. R. E. Crompton; Dr. John Hopkinson, F.R.S.; Mr. Jeremiah Head; Prof. J. B. W. Kennedy, F.R.S.; Sir Henry Mance (President of the Institute of Electrical Engineers) and Lady Mance; Mr. J. Macfarlane Gray; Mr. W. H. Preece, C.B., F.R.S.; Mr. and Mrs. J. S. Raworth; Prof. and Mrs. Henry Robinson; Mr. Jas. Swinburne; Prof. W. C. Unwin, F.R.S.; Mr. Frank Wynne; Sir Richard Webster, G.C.M.G., Q.C., M.P. (Attorney-General). A good programme of vocal and instrumental music was a great attraction.

Magnetic Separation of Non-Magnetic Material.—Before a recent gathering of the American Institute of Mining Engineers at Chicago, Dr. R. W. Raymond contributed to the discussion on a paper which had been read by Messrs. Wilkens and Nitze on the above subject. Dr. Raymond stated that the authors' allusion to the gap between the strongly and the weakly paramagnetic substances might be more fully illustrated by a reference to the work of Plücker, whom the authors mentioned in passing. His paper on the subject is in Poggendorff's *Annalen*, Vol. lxxiv., for 1848. Taking the magnetic attractability of iron as 100,000, he determined that of other substances by careful experiment. The following instances, extracted from a larger number in his paper, will be interesting in this connection:—Magnetite, 40,227; red hematite, 134; specular iron ore, 533; hydrated ferric oxide, 156; limonite, 71; dry persulphate of iron, 111; protosulphate (iron vitriol), 98; pyrite, 150; hydrated Mn_2O_3, 70; Mn_3O_4, 167. It is evident that determinations of the magnetic attractability of natural minerals must be affected by their degree of purity, and also by their chemical and physical condition. To meet these points partly, Plücker calculated this function for the amount of iron, manganese, &c., present in the minerals examined, obtaining the following figures:—Iron in magnetite, 55,552; iron in red hematite, 191; iron in specular iron ore, 761; iron in hydrated ferric oxide, 296; iron in dry persulphate, 349; iron in protosulphate, 385; iron in pyrite, 321; manganese in hydrated Mn_2O_3, 112; manganese in Mn_3O_4, 232. He found also a great difference between two forms of anhydrous ferric oxide (the second probably being colloidal), of which one showed a susceptibility of 500, and the other of 286, the figures for the metallic iron in them being, respectively, 714 and 409. His results do not agree in all respects with those of Wiedemann, or with the results of experiment by the Wetherill machine. A striking instance of discrepancy is furnished by pyrite and iron vitriol, the former of which Plücker rates at 150, and the latter at 98. Yet Dr. Raymond was able, with the Wetherill machine, to take up practically the whole of a charge of powdered iron vitriol, whereas it has not yet been found possible to effect with that machine any extraction of pyrite. Very possibly some adjustment of quantity and intensity of current, in connection with the machine, may hereafter be found, by which it will be made effective upon a wider range of materials than has been successfully treated so far. Meanwhile, it may be said that at the present stage of this apparatus and its manipulation, the results obtained by it do not exactly agree with any of the laboratory lists of relative attractability heretofore published by scientific investigators. The causes of discrepancy will furnish an interesting field for further inquiry. It is pretty certain, however, that the ultimate range of the apparatus will be confined wholly to paramagnetics, and none of the diamagnetics will be added to that list. Under this latter head, Faraday included bismuth, antimony, zinc, cadmium, sodium, mercury, lead, silver, copper, gold, arsenic, uranium, rhodium, iridium, and tungsten, while he placed among the paramagnetics iron, nickel, cobalt, manganese, chromium, cerium, titanium, palladium, platinum, and osmium. Some of these latter are doubtfully classified. Messrs. Wilkens and Nitze have not clearly succeeded in attracting, thus far, any minerals not containing either iron or manganese. What they may accomplish hereafter among the other paramagnetics will be watched with interest.

A New Feed Wire Splicer.—The splicing of electric railway feed wires is at the best a difficult task, and any new means of facilitating and rendering such operations less troublesome are always hailed with satisfaction by railway constructors and managers. The device illustrated herewith, which is made by the Ohio Brass Company, Mansfield, Ohio, has for its object this very purpose, and as it is rational in design and application, it will likely find a quick market. It affords a practical means of making a cheap, quick and effective splice in feeder wires, and in connection with larger gauges it offers special advantages. The splicer is made, says the *Electrical World*, in two parts, which are exact duplicates of each other, except that one is slotted to allow solder to be poured through it. The parts are dovetailed together when in position and held by two nuts threaded externally on their ends. The inside diameter of the central portion of the splicer is a trifle larger than the



wire, which permits of the accumulation of a sufficient quantity of solder at that point to ensure a perfect electrical and mechanical connection. The extremities of the splicer are tapered and slightly corrugated on the inside, and when the abutting ends of the wire are clamped and the nuts screwed tightly in place, they are held securely in position. The device, it is evident, can be used as a permanent or temporary connector, and it works equally well with solid or stranded conductors. For hard drawn wire the splicer is slightly different in construction from that above described, which is intended for soft drawn copper wire. The greater tensile strength of the hard wire requires a stronger method of splicing, and to accomplish this the wires are headed on their ends by a special riveting tool before they are placed on the splicer. The inside of the splicer is so constructed that the heads seat themselves against a shoulder, which arrangement, together with the solder used, makes a joint the full tensile strength of the wire itself.

Electrical Works and Lead Poisoning.—In the House of Commons on Monday, Sir M. W. Ridley, in answer to a question by Mr. M'Kenna as to the case of J. A. Garvey, aged 17, a lead filer, lately employed at the Electrical Power Storage Company's Works, Millwall, who had died from the effects of lead poisoning, said his attention had been directed to the case, but he had been unable to learn that there had been any breach of the Factory Acts or of the special rules which had been made for electric accumulator works. Employers were required by those rules to provide a bath; this was done at the works in question, and a time for bathing was appointed for each person employed. It was not obligatory at present, however, on the workers to use the bath, and he regretted to find that at these works bathing had often been omitted. It might become necessary to take steps to remedy this.

Cox Generator.—An American exchange says that Mr. H. B. Cox, inventor of the Cox thermo-electric generator, is in America on a business trip to complete important negotiations, and close up arrangements for the handling of his apparatus in that country, where a large demand is stated to have sprung up. Mr. Cox is said to have been invited to deliver two lectures before the Royal Institution on his investigations and work, but before returning to England will deliver an experimental lecture before the New York Electrical Society.

Institution of Electrical Engineers.—The next visit of the students of the above Institution will be to the works of "The India-Rubber, Gutta-Percha and Telegraph Works Company" on Saturday, June 12th. The party will meet at the 9.40 train at Fenchurch Street Station, and arrive at Silvertown at 10.4. As the number will have to be limited, those who wish to attend must send in their names at once to the Hon. Secretary of the Students' Committee (Mr. W. Bunn, 23, Oxford Road, Stroud Green, N.).

Thermal Couples.—Our old friend the *English Mechanic* gives a few particulars of an electric pyrometer, intended for factory purposes. It is a thermal couple of platinum and platinum-rhodium, protected by a porcelain tube; not much of a novelty perhaps, but it seems to have the makings of a useful instrument for rough and ready work. In thousands of practical cases, especially in factories, there is need for thermal measurements in that unfortunate zone just above the boiling point of mercury. Great accuracy is not required, a margin of 10 or 20° can easily be allowed, but the instrument must be direct-reading, and its scale must be as plain as a pike-staff. Platinum thermometers are admirable in their way, but at present they are just too elaborate, and somewhat too costly; they ought to be reduced down to a mere clock-face with a stem sticking out of it, something like a hot-wire voltmeter. The casing and stem must be unaffected by ordinary vapours; delta-metal would probably do for this purpose. Thermal couples, according to our experience, are easy to make and easy to use; but difficult to calibrate and difficult to keep calibrated. The essentials are, a circuit of low resistance, a galvanometer of a few thick turns, and joints above suspicion—the least fortuitous change of resistance is fatal. A thermal couple of delta-metal and iron, silver-soldered, may be tried as an experiment; it has rather a useful range of temperature. In most cases it will be impossible to use a reflecting galvanometer, it is here the difficulty begins; the pivoted instruments give a very limited range, and introduce errors of "stixion," multiplied by magnetic changes. In a word, the galvanometer "constant" is not a constant. The scale ought to be calibrated directly in thermal degrees by means of platinum thermometers; probably Kew would accept work of this kind, if anything like an efficient instrument were sent to them. If any part of the range of temperature happened to be within the limits of the mercury thermometer, the re-calibration could always be effected by a slight change of resistance of the thermo-electric circuit. In the laboratory the platinum-thermometer and the thermal couple are instruments of precision; we are willing to dispense with some of the precision if only a practicable temperature gauge can be provided in its place, right to within say five per cent. By the way, Lord Kelvin, at the Royal Institution last Friday, gave a very suggestive analogue of the "inversion" of the thermo-electric power of a given couple. He compared it to the change of density of water as it passes at 4° C. through a maximum. Thus, starting at 0° C, the change of density may be regarded as *positive* as 4° is approached, and *negative* as the temperature continues to increase beyond that point.

India-Rubber in West Africa.—The British India-Rubber and Exploration Company, Limited, with a capital of £200,000 in £1 shares, and £100,000 worth of 6 per cent. first mortgage debentures, has been formed to acquire a large rubber growing territory on the West Coast of Africa. In our issue of April 9th last there appeared an article entitled "India-Rubber Plantations," which may be read, we hope with advantage, by those interested in the above company, whether directors or shareholders. We cannot foretell the future of this concern, but one must remember the very unexpected and sudden rise in the production of rubber at Lagos, where from practically nothing the production rose in two years to the value of £270,000.

"A Booster."—The *American Electrician* recently gave the following description of a booster:—"A booster consists of an armature driven in a magnetic field, and through whose windings passes the entire current of the circuit in which it is placed, its object being to increase the voltage of the circuit. Usually there is a combination of two direct connected machines, one of which acts as a motor, and drives as a dynamo the other machine or booster. Sometimes there is a single field with the motor and booster windings on the same armature. A booster may be used on an electric railway feeder leading to a distant point, in order to raise the E.M.F. of that feeder sufficiently above the station E.M.F. to compensate for its abnormal drop; or in an auxiliary storage battery installation to add sufficient E.M.F. to the dynamo voltage to charge the cells."

Lighting the Blackwall Tunnel.—Royalty opened this splendid piece of engineering work last Saturday, and a few notes as to the lighting plant are given by a daily paper. There is a large generating station on the Poplar side of the river, where three Lancashire boilers supply steam for driving five compound steam dynamos, three being of 120 H.P. and two of 60 H.P. These supply current for lighting the tunnel from end to end, but also furnish electric power for six motors which operate pumps and lifts, also tools in the workshop attached to the generating station. Mr. T. P. Gunyon is the Council's chief electrical engineer.

Marriage.—The marriage of Mr. John Verity, J.P., and Miss Evelyn Mary Lubbock, the approach of which had already been announced in these columns, took place on Wednesday afternoon, at Holy Trinity Church, Chelsea. A reception was afterwards held at 26, Cadogan Gardens. Mr. and Mrs. John Verity left for Sandbridge Bury, *en route* for Paris. Among many presents were a silver candelabra and silver tea set from the employés of Veritys, Limited.

Personal.—Mr. W. J. Croft has been appointed chief engineer to the Army and Navy C. S., Limited, Westminster, and will shortly vacate the post of chief electrical engineer to Messrs. Baxendale & Co., of Manchester.

Damages.—Mrs. Bryan has just been awarded £125 damages for injuries received on July 4th, 1896, when she fell into a hole which had been left improperly protected by the Shoreditch Vestry, who were laying the electric light mains at the time.

The Canadian Tariffs.—The Canadian Government has made an alteration in its original preferential tariff proposal, and one item affected is covered wire for electrical purposes, the preferential duty on which will be 18¾ per cent. instead of 15 per cent. as before proposed.

The Decimal System.—A friend writing from the Continent under date of May 25th, says:—"I saw you had a note about the decimal system in your last REVIEW. I send you this to say that the French Chamber has under consideration the issue of a new coin. They find the centime system is not a success, and are about to issue a coin equivalent to our farthing, viz., 2½ centimes, in other words a half-sou. Verily the aliquot parts will assert themselves."

The Institution of Junior Engineers. — To-day, Friday, May 28th, at 6 p.m., a visit is to be paid to the Electric Welding Company's Works, at 21, Hindon Street, Pimlico. (Reginald J. Wallis-Jones, Esq., engineer and manager.) A progressive series of operations, illustrating the variety of applications of electric welding, will be shown, commencing precisely at 6 p.m. On Saturday, June 5th, at 3.30 p.m., the Refrigerating, Electric Lighting, and Hydraulic Stations of the Victoria and Albert Docks (H. F. Donaldson, Esq., engineer) will be visited.

Obituary.—The death is announced of Mr. James Stiff, of the London Pottery, Lambeth, at 86 years of age.

Central London Railway.—The contract for the electrical work for this railway has been given to the British Thomson-Houston Company. The total of the contract is £275,000. We understand that three-phase plant is to be installed.

NEW COMPANY REGISTERED.

English Varley Duplex Magnet Company, Limited (52,658).—Registered May 22nd with capital £10,000, in £10 shares, to adopt an agreement with R. Varley and the Varley Duplex Magnet Company, and to carry on the business of electro-magnet and electro-bobbin manufacturers, electricians, electrical and mechanical engineers, &c. The subscribers (with one share each) are:—B. Varley, 9, Reginald Street, Derby, railway official; G. Sutherland, Arboretum Street, Derby, gentleman; L. J. C. Smith, 10, Wilson Street, Derby, traveller; T. Goldthorpe, 13, Reginald Street, Derby, traveller; G. Y. Mills, Mill Hill, Derby, architect; G. Palmer, 8, Swinburne Street, Derby, surveyor; T. Eaton, Littleover Hill, Derby, railway official; G. D. Dennis, 26, Newton Road, W., engineer. The number of directors is not to be less than three, nor more than five; the first are the first four subscribers. Qualification £200; remuneration as fixed by the company. Registered by Jordan & Sons, Limited, 120, Chancery Lane, W.C. Registered office, 24, Strand Chambers, Derby.

CITY NOTES.

Oxford Electric Company.

EXCELLENT and economical management has always been a marked characteristic of the Oxford Company, and the following analysis shows that there has been no falling away during 1896. The general statement of affairs has been already given in these columns, both in the accounts and in the report of the meeting.

The following table gives the cost per unit:—

	1896.	1895.
Total capital expended...	£75,903	—
Number of units sold	291,640	—
Number of lamps connected	—	—
Revenue from sale of current	£7,322	—
Net revenue	£3,368	—
Average price obtained per unit ...	6·02d.	—

Cost of Production.	£	s.	d.	Per unit.
Coal	701	0	0	·58d.
Oil, waste, water, and engine room stores	79	0	0	·06d.
Salaries and wages at generating station	905	0	0	·74d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	946	0	0	{Works' cost 2·17d.} ·79d.
Rates and taxes	309	0	0	·25d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	1,239	0	0	1·02d.
Depreciation of buildings and plant account	—			—
Renewal fund account	—			—
Total	£4,179	0	0	3·44d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	7,322	0	0	6·02d.
Meter rents	109	0	0	—
Other items	117	0	0	—
Total	£7,549	0	0	6·02d.

Total cost per unit (exclusive of depreciation and renewal accounts), 3·44d.; works' cost, 2·17d.

The Reading Electric Lighting Co.

THE results of the year's working of this company have already appeared in these columns, and little more remains to be said about them. The analysis of the cost of production is given below, and shows that the revenue for current is slightly less than the cost of producing that current. It is hardly necessary to say that the company had not, in the accounts referred to, began to feel the benefits of their extended plant and their greatly increased *clientèle*. The next accounts will, no doubt, show most marked improvements in the year's working.

The following table gives the cost per unit:—

	1896.	1895.
Total capital expended	£35,212	—
Number of units sold	82,250	—
Number of lamps connected	8,700*	—
Revenue from sale of current	£2,056	—
Net revenue	39	—
Average price obtained per unit... ...	6·0d.	—

* December 31st.

Cost of Production.	£	s.	d.		Per unit.
Coal	613	0	0		1·78d.
Oil, waste, water, and engine room stores	74	0	0		·22d.
Salaries and wages at generating station	546	0	0		1·59d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	90	0	0	(Works' cost 2·84d.)	·26d.
Rates and taxes	187	0	0		·54d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	275	0	0		·80d.
Depreciation of buildings and plant account	—				—
Renewal fund account	—				—
Total	£17,895	0	0		5·17d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	2,056	0	0	6·0d.
Meter rents	77	0	0	—
Sale of Lamps	—			—
Total	£2,133	0	0	6·0d.

Total cost per unit (exclusive of depreciation and renewal accounts), 5·17d.; works' cost, 2·84d.

Bournemouth and District Electric Supply Co., Limited.

The general result of the year's operations of this company were shown in the report published a short time ago. The net revenue for the year was £2,283; the accounts altogether indicating steady and continuous progress.

The following table gives the cost per unit:—

	1896.	1895.
Total capital expended	£79,334	—
Number of units sold	281,310	—
Number of lamps connected	—	—
Revenue from sale of current	£7,588	—
Net revenue	£2,283	—
Average price obtained per unit	6·49d.	—

Cost of production.	£	s.	d.		Per unit.
Coal	1,676	0	0		1·43d.
Oil, waste, water, and engine room stores	481	0	0		·41d.
Salaries and wages at generating station	1,378	0	0		1·18d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	1,304	0	0	(Works' cost 4·13d.)	1·11d.
Rates and taxes	123	0	0		·10d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	928	0	0		·79d.
Depreciation of buildings and plant account	—				—
Renewal fund account	—				—
Total	5,890	0	0		5·02d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	7,588	0	0	6·24d.
Meter rents	413	0	0	—
Sale of lamps	—			—
Total	£8,001	0	0	6·24d.

Total cost per unit (exclusive of depreciation and renewal accounts), 5·03d.; works' cost, 4·13d.

The West African Telegraph Company, Limited.

The report and accounts of the directors for the year ended December 31st, 1896, to be presented to the twelfth ordinary general meeting, to be held at Winchester House, 50, Old Broad Street, London, E.C., on Thursday, June 3rd, 1897, at 3 p.m., states that the company's revenue for that period amounted to £70,989 18s. 10d., against which £17,898 4s. 1d. is charged for ordinary expenses, and £20,695 6s. 4d. for expenditure relating to repairs of cables, &c. After providing £797 18s. 7d. for income-tax and £172 10s. 2d. due to re-valuation of currency assets, there remains a balance of £31,425 19s. 8d., to which is added £1,760 5s. 8d. brought from the preceding year, making a total available balance of £33,186 5s. 4d. From this balance there has been deducted £10,726 15s. 4d. for interest on debentures, and £13,000 for sinking fund, leaving £9,459 10s., out of which the directors have placed £9,000 to the general reserve fund, and the balance of £459 10s. is proposed to be carried forward to next year. We record with regret the decease of Sir John Pender, chairman of the company, on July 7th last. The Most Hon. the Marquis of Tweeddale, has been elected to fill the vacant seat. The director who retires by rotation is the Most Hon. the Marquis of Tweeddale, who, being eligible, offers himself for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., also retire, and offer themselves for re-election.

Hastings Electric Light Company, Limited.

The ordinary general meeting of this company was held on Tuesday, under the presidency of Mr. F. A. Langham. The report stated that the accounts indicated an increase in the income of nearly £1,000 for lighting, and the demand for the light continues. The company were, however, unable to obtain an increase of capital, either to the extent or at the rate of interest they desired, to meet the demand. The balance against the company had been reduced from £667 8s. 9d. to £116 2s. 3d.

The Chairman, in moving the adoption of the report and balance-sheet, said that with regard to the determination of the Town Council to take over the public lighting, he did not know whether they would be in a position to take it over by June 30th, or whether they would desire the company to continue the contract until their installation works were in readiness. There was no reason why the company should not go on with it until September 30th, and it would pay them very well.

Mr. A. Bray seconded the motion, which was carried.

An extraordinary meeting was then held to consider the proposed sale of the undertaking to the Hastings Corporation. The Chairman said that, as a result of the negotiations, the company had offered to sell the concern for £58,000. He would not have advocated the proposal if they were in a position to raise money at 3 or 4 per cent., but seeing that there must be a constant demand for additional capital which they could only raise at 5 and 6 per cent., he thought it would be wise, if the Corporation would give them enough, to put their money back into their pockets, to sell. It would be handing over what would prove a great benefit to the ratepayers. The Corporation had said that they should not be required to pay for the purchase until March 31st next, and that the company should carry on the business until that time, and they undertook that whatever was spent on capital by the sanction of their engineer would be repaid. He moved that the directors be authorised to enter into a provisional contract for the sale of the undertaking for £58,000, and to carry the same into effect in the manner at the time they thought proper.

Mr. H. M. Baker seconded, and the resolution was carried.

Reuter's Telegram Company, Limited.

The annual general meeting was held on Wednesday at 8, Old Jewry, E.C., Admiral Sir J. D. Hay, Bart., presiding.

In moving the adoption of the report, the Chairman said the profit made in 1896 was only £90 less than in 1895. In other words they made last year £9,531, as against £9,621 the year before. While, however, the result of the year's operations was a source of gratification to the board, their greatest satisfaction was to see the reserve increased to the considerable sum of £20,000. Turning to the accounts, he said the three items on the credit side of the account, representing their resources, exceeded their outside liabilities by £21,581. He congratulated the shareholders on the prestige which the company's news service continued to enjoy. The company had spared no pains to maintain the high standard of its service, and its endeavours had been successful. With regard to the current year, present appearances pointed to their being able to earn a satisfactory dividend; but 1895 and 1896 were exceptionally good years.

The motion was carried.

Stock Exchange Notices.—The Stock Exchange Committee have—(1) Appointed a special settling day as under:—Wednesday, June 2nd. City and South London Railway Company—20,000 5 per cent. perpetual preference shares Nos. 15,001 to 35,000 (1896). And (2) ordered the undermentioned securities to be quoted in the Official List:—City and South London Railway Company—20,000 5 per cent. perpetual preference shares, Nos. 15,001 to 35,000. (1896). Commercial Cable Company—Further issue of £253,586 sterling 4 per cent. 500 year debenture stock.

Brazilian Submarine Telegraph Company, Limited.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income-tax, for the quarter ended March 31st, 1897, and payable on June 19th. The transfer books will be closed from June 12th to the 18th, both days inclusive.

Calcutta Electric Supply Corporation, Limited.—The first batch of letters of allotment and regret for the capital offered for subscription have been posted.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending May 23rd, 1897, were £958; week ending May 24th, 1896, £898; increase, £65; total receipts for half-year, 1897, £21,461; corresponding period, 1896, £19,693; increase, £1,768.

The Liverpool Overhead Railway Company. The receipts for the week ending May 24th, 1897, amounted to £1,386; corresponding week last year, £1,178; increase, £208.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 21st, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,162.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, May 19th.	Closing Quotation, May 26th.	Business done during week ended May 26th, 1897. Highest.	Lowest
149,900£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 —104	100 —104	101	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	4 — 5	4 — 5	...	...
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	49 — 52	49 — 52	...	...
3,038,020'	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	93½ 94½	94 — 95	94½	93¾
3,038,920£	Do. do. Defd.	Stock	...	...	...	7⅜ — 8¼	7⅜ — 8¼	...	...
120,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	14⅜ — 15½	15 — 15½	15½	15
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	113 —117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	...	3¼ — 3⅜	3½ — 3⅜	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	73 —177	173 —177	...	...
400,000£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	100 —101	101 —102	101⅝	100¾
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	2 %	⅞ — ⅞	⅞ — ⅞	...	...
15,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	9½ — 10½	9½ — 10½	10 1/16	10
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	19¼	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3¼ — 4½	3¼ — 4½	3⅜	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	9½ — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	105 —108%	105 —108 %	...	...
89,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	8¼ — 9	8⅜ — 9½	9	8 7/8
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	16⅜ — 17½	16½ — 17½	17⅛	16⅜
76,000	Do. 6 % Cum. Pref.	10	6 %	6	...	18 — 19	18 — 19	18⅝	18¼
89,900'	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	103 —106	103 —106	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	127 —130	127 —130	129½	127½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	%	17⅜ — 18¼	17⅜ — 18¼	18 3/16	17 15/16
35,500£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5%	100 —104	101 —105	103½	...
133,100£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	101 —104	102 —105	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	128 —131	128 —131	...	...
51,100'	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	100 —104	101 —105	...	...
69,200'	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	101 —104	102 —105	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	107 —110	105 —108	...	...
250,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	107 —110%	107 —110 %	...	...
189,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11 — 11½	11½ — 11⅝	11⅝	11½
180,642	Do. do. 6 % Pref.	10	6 %	6 %	...	17 — 17½	17 — 17½	17 3/16	17 1/16
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	10 %	10⅜	24½ — 25½	24½ — 25½	25½	25⅛
160,000'	Do. do. do. 5 % Debs.	100	5 %	5 %	5⅛	102 —105	102 —105	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10⅜	53 — 56	54 — 57	56	54⅜
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	107 —110	107 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5½%	5½%	6⅜ — 6⅝	6⅜ — 6½	6⅝	6 9/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	6⅜	...
1,329,471'	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —109	105 —109	107½	106½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	5 %	⅝ — ¾	⅝ — ¾	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	107 —110	107 —110	...	...
11,839	Reuter's Ltd.	8	nil	5 %	5 %	7 — 8	7 — 8	7¾	7 3/16
3,281	Submarine Cables Trust	Cert.	...	...	...	135 —140	135 —140	136½	...
58,680	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3¼ — 3⅜	3½ — 4	...	...
145,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	100 —105	100 —105	...	...
15,809	West African Teleg., Ltd., 7,501 to 23,189	10	nil	4 %	...	5 — 6	5 — 6	...	...
213,400	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 —104	101 —104	...	...
30,000	West Coast of America Teleg., Ltd.	10	nil	nil	...	¾ — 1¼	... ...	...	...
150,000	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	103 —108	... ...	...	...
64,256	Western and Brazilian Teleg., Ltd.	15	3 %	3 %	2 %	7½ — 8	7⅜ — 8¼	8 1/16	7⅞
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6¼ — 6⅜	6½ — 7	...	...
33,129	Do. do. do. Def. Ord.	7½	1 %	1 %	...	1½ — 2	1⅜ — 2¼	1 15/16	1⅞
88,821	West India and Panama Teleg., Ltd.	10	⅛%	⅛%	1 %	⅜ — 1⅜	⅜ — 1⅜	1	...
24,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 11½	11 — 11½	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9½ — 10½	9½ — 10½	...	...
36,680£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	107 —110	107 —110	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$100	7 %	7 %	7%	104 —108	104 —108	...	...
162,200	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6%	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	11½ — 12½	13 — 14	13⅝	12⅜
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6¼ — 6⅜	6⅜	6¼
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	8¾ — 9¼	10¼ — 10⅜	10⅜	9
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	4½%	4½%	112 —115	112 —115	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	23 — 24	23½ — 24½	24½	23⅜
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17 — 18	17 — 18	17 1/16	17¼
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	131 —136	131 —136	134½	134
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	nil	nil	12¼ — 12⅜	12½ — 13	12⅞	12 7/16
10,000	Do. do. do. 6% Pref., 40,001—50,000	10	...	6 %	6 %	14⅜ — 15½	15 — 15½	15⅜	14 13/16
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	..	14⅜ — 15½	14⅜ — 15½	14⅜	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	8¼ — 8⅜	9¼ — 9⅜	9½	8½
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	3 %	4 %	5 %	17 — 18	17 — 18	17⅜	17½
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	13½ — 14½	13½ — 14½	14 5/16	14 1/16
220,000.	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	120 —124	120 —124	122½	122
5,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	14 — 15	15 — 16	15½	15⅜
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	15½ — 16½	15½ — 16½	16	
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	10⅜	10⅜
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
47,900	*Westminster Electric Supply Corp., Ord., 101 to 50,000 ...	5	5 %	7 %	9 %	15 — 16	15½ — 16½	16	15

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

§ Dividends marked § are for a year consisting of the latter part of one year and the first part of the next

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, May 19th.	Closing Quotation May 26th.	Business done during week ended May 26th, 1897. Highest.	Lowest
98,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	2½%	...	...	1⅛ — 1⅜	1¼ — 1½	1 7/16	1¼
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	1½ — 1¾	1⅝ — 1⅞	1 11/16	...
125,000	Do. do. 4½ % Perp. Deb. Stock... ...	Stock	4½%	...	...	104 —108	104 —108	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	95 — 99	95 — 99	...	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	9¾ — 10¼	9¾ — 10¼	...	...
143,103	Do. do. do. £6 paid	10	...	...	...	5¾ — 6	5¾ — 6¼	5 15/16	5⅞
51,951	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½ — 1⅝	1½ — 1⅝	1⅝	1 7/16
54,571	Do. do. Def. do. £5 pd. ...	...	...	...	...	4¼ — 4⅜	4¼ — 4⅜	4⅜	4 5/16
630,000	City and South London Railway	Stock	1⅛%	1 3/16%	1 9/16%	58 — 60	58 — 60	59⅛	59½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	1⅞ — 2¼	1⅞ — 2¼	2	1 13/16
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	...	1⅞ — 2¼	1⅞ — 2¼	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	...	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	4½%	4½%	...	105 —110	105 —110	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	...	1⅝ — 1⅞	1⅝ — 1⅞	1⅝	1 11/16
16,343	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2¾ — 3¼	2¾ — 3¼	2⅞	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	¾ — 1	¾ — 1	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	¼ — ½	¼ — ½	...	...
9,600	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	10½%	...	11 — 13	11 — 13	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	18 — 19	18 — 19	...	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	18½	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	108 —113	108 —113	...	...
68,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	20½ — 21½	20¼ — 21½	21⅜	21
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	104 —107	104 —107	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	2⅞%	2⅞%	12⅜ — 12⅞	12 1/16 — 12 5/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15½ — 16	15¾ — 16¼	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	34 — 37	34 — 37	36½	35½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	103 —106	103 —106	105½	103½
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	10	...	...	...	10⅜ — 11¼	10⅜ — 11¼	11	...

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9¼.
British Electric Traction, 12⅜—13¼.
Electric Construction Corporation, 6 % Debentures, 103—106.
House-to-House Company, 7 % Preference, of £5, 10—10½.
Do. do. 4½% Debentures of £100, 109—111.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 12¼—12⅜; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Dividend, 1896, on Ordinary Shares 7 %.
London Electric Supply Corporation, £5 Ordinary, 1⅞—2⅛.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8⅜—8⅝. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount, 2 per cent. (May 13th, 1897).

STEAM BOILERS BURNING NATIVE COAL.

RECENT legislation in South Africa seems likely in the near future to have the desirable effect, as far as colonial interests are concerned, of displacing nearly, if not all, the coal that is at present imported, and substituting for it the native article; and if this is the case, it behoves engineers to consider somewhat closely the properties of the latter, and the methods generally adopted for burning inferior qualities of fuel. Most of what is obtained on the spot is very friable, and of a duty only about one-half the best Welsh. Deduced from this there are certain facts to attend to in burning the former class in boilers if we wish to do so with economy. By a coal of one-half duty, it is understood that double the quantity has to be consumed on the fire grate to evaporate the same amount of water in the same time. If this last point is not taken sufficiently into account, we may be working economically enough, but, like the laggard, continual urging will be necessary if a given task has to be accomplished. Possessing such large fields, however, in the colony, there is now every inducement offered to railway companies and large users to give colonial coal a fair trial, and study the means of doing so.

For this purpose boilers, to give no trouble, should be of larger grate area, and have a proportionately increased fire box. But as only the same quantity of water has to be converted into steam, we cannot, as a rule, add much in surface on which to lay our fire without also making more work for the heat generated, and so losing in one way what is gained in the other. Taking the locomotive type as an example, it is readily observed that if we lengthen the grate, there being always the same depth of water above the fire box, that though we do not thereby lengthen the whole boiler and so use up water in the same proportion, we do make some extra work for the fire to do. The tubes remaining the same, whatever further power we are able to ensure by a greater area of fire, we have the drawback of increased resistance in the amount of cold water requiring to be turned into steam. With the problem before him, however, the engineer is not accustomed to look on anything as impossible, and having to get through certain work, that is to say, evaporate so much water into steam, the first point to consider is the weight and type of boiler, according to the requirements, and these important preliminaries settled, the best is done with the furnace and firegrate as far as size goes. With the main dimensions fixed, these two items are made as large as possible. Experience and calculation then foretell the probable results. The same class of boiler has given, say, 9 lbs. of water, converted into steam, for every pound of the best coal; but nothing like this can be expected under present circumstances, and even after all has been done in the way of increasing the grate and furnace, there may be a reduction of as much as 35 per cent. on the above rate of evaporation. To carry a heavy fire is one way out of the difficulty; but again trouble ensues, because the coal cannot be burnt effectively when lying in a dense mass on the grate. Owing to the thickness, air is not able to permeate through, as it would if the layer were thin, and as oxygen is a necessary corollary to perfect combustion, it is found probably in the end that every particle of fuel not receiving its proper share, a large loss follows, because some pure carbon runs away to waste unburnt with the ash. Supposing then the size and number of boilers to be determined, resort must be had to some expedient for combating this drawback. The larger grate has given some compensation for the low quality fuel being used; but as this does not furnish enough heat, even then a special aid to combustion is wanted. Having a light friable coal to deal with, there will not be the same difficulty as there would be with a heavier and denser kind, for the air can penetrate more readily; but still there is always the larger proportion of ash made at any time, and this is of course intensified by the greater volume to be consumed. This ash falling on the grate has the tendency to clog the bars, and prevent admission of air. One method generally in vogue for freeing the fire from this trouble, and therefore attaining the end required is to agitate the grate bars. This is done with

a two-fold object; the ash and clinker are thereby prevented from adhering to the bars and carried into the ashpit, so that fresh air can get to the fuel. An effective way of doing this is of the greatest assistance where the grate is small for the duty wanted from the coal. It is not necessary to keep the bars in constant motion, because of the tendency there is for the grate to act as a sieve, and riddle coal away with the ash. All that is required is for the attendant to be provided with a simple means of clearing the grate when dull, thus admitting more air, loosening the fire right through and promoting combustion. A thicker layer can in this way be carried, and the drawbacks of the lower grade of coal be greatly ameliorated. It may be urged that there is the mechanical action of such an apparatus to be weighed against any advantages gained, and no doubt this holds good to some extent. Well chosen systems are to be found, however, practically everlasting and simple in construction, which are known to make a very large saving, nearly enough to turn the balance against the inferior fuel into an even figure. Some of these are in use already in the colony. Another plan adopted for carrying a thick fire is to blow a blast of air under the grate, and this acts as a continual aid to combustion, but as some power is expended in the operation either by way of steam used up direct or other force employed, there is a set off against any gain that may thus result. Moreover, in locomotive boilers such blast is already present in the draught generated in the funnel, and therefore in this class inadmissible.

Generally, therefore, it is seen that by judicious management much may be done by colonial mined coal in the way of competition with that which is imported when the new regulations come into force. Though it is undoubtedly best to burn smokeless Welsh, yet there are opportunities for attaining fair comparative results from that ready to hand, under a system of protection. We have named some of the leading features that rule when working with the latter kind, and already well known to users in the colony; but if there is an ample supply of boiler power available, these would be to some extent modified. If desiring, however, to economise, we shall always be driven back to much the same conclusions, because an extra number of generators means additional expense in every way, and does not strike at the root of the evil, viz., size of grate and rate of evaporation if we have a low class combustible to deal with. For the same sized boiler for power under these conditions, it is essential that the volume of water be kept as small as possible, and special care is therefore necessary, both in design of boiler and mechanical appliances for increasing the consumption on the fire grate, if it is desired to burn the inferior fuel against that sent out from England, even though with the assistance named.

PROCEEDINGS OF SOCIETIES.

Northern Society of Electrical Engineers.

THE TRANSMISSION OF POWER IN FACTORIES BY ELECTRICITY.

Read Monday, May 17th, 1897, by S. V. CLIBEHUGH, Member.

(*Concluded from page 723.*)

I have had occasion to use in different works three different classes of motors:—

1. The enclosed water-tight motor.
2. The enclosed ventilated motor.
3. The unenclosed motor.

I cannot urge members of this Society too strongly to use only enclosed watertight motors where the place is either steamy at any time, or where the machines themselves throw off water while working. The cost is doubtless increased, since it may be assumed to enclose a motor, and keep to the same temperature limit as an unenclosed motor, or reduces the output 25 per cent.; but when you see the actual experience that motors have to go through, there can be no doubt that the additional expenditure is not only wise, but requisite. I have been surprised to find firms of standing suggesting that this was unnecessary, and that a wooden case was all that was required.

With regard to the enclosed ventilating motors, the enclosing, of course, is the only expense, the temperature rise of the motor remaining the same. The unenclosed motors require no special comment, beyond that I think a better protection than a wooden box is a sort of wire cage. I think that under no circumstances should a motor be left absolutely unprotected.

Motors which are to be left in the works, where they will receive practically no attention except oil, must be able to run absolutely sparklessly at all loads up to 30 per cent. overload without moving the brushes. These I have succeeded in getting, and at no undue cost, compared to makers' lists.

A word of warning with regard to carbon brushes on enclosed motors may save some the trouble which I have experienced. If you use carbon brushes in an enclosed motor you cannot keep your temperature down unless the E.M.F. is considerably higher than 200 volts, and this with a large amount of surface. The inability to use these brushes is, in my opinion, no particular drawback. Carbon brushes cover a multitude of sins, and much sparking may go on undetected for a time. In addition, as far as my experience goes, it is impossible to avoid the presence of foreign matter which will often cut the commutator, and if not checked very early will cause considerable damage. I have found that wire brushes, not gauze, once they get nicely bedded, will run for six months without any attention, provided, of course, the motor does not spark.

I have recently been obliged to use some slow speed motors, 350 revolutions for about 18 H.P., and have obtained some four-pole machines, which, up to the present, are giving every satisfaction, and whose cost, having regard to the speed, came out very reasonably.

The variation of speed is the next item. This is the sort of problem required to drive a callender which shall be able to run at any speed between zero and 50 revolutions per minute; its principal speeds, however, will be 25, 35, and 50 revolutions per minute. The method I have adopted in some cases is as follows:—Make the normal speed of the callender motor 35 revolutions per minute, plus the increase due to the gearing, so that when running at this speed there is no resistance in circuit with it. When the higher speed is wanted, this is obtained by putting resistance in the field, *i.e.*, by weakening the field and so decreasing the back E.M.F. and allowing more current to flow. This, of course, somewhat lowers the efficiency of the motor, but does away with any loss worth mentioning in the resistance. About 50 per cent. increase is probably about the maximum obtainable in practice without sparking. When a speed lower than 35 revolutions is required, it has to be obtained by putting resistance in series with the armature. This is, of course, wasteful.

I do not think that water resistances are suitable, except for starting resistances, as if they have to be kept in circuit, they require considerable attention, and become a nuisance. I have here a switch pillar, which is, I think, very good. It is massive and self-contained. It cannot be injured, and the current cannot be put on too suddenly, as the attendant has to change the position of his hand before he can make a complete revolution, and it is quick break throughout.

One secret of success and economy in electric power installations is to consider very carefully the machine you have to drive, and to spend a long time in its company. No information as regards the most usual speeds at which a machine is run is obtainable as a rule.

The wiring should be run on insulators strained tight, and out of reach. Where it is brought down to a machine, it should be enclosed in gas barrelling 6 or 7 feet up. All motor wires should, in my opinion, be taken back to a distribution switchboard, on which one ammeter should be fixed, and the bus bars so arranged that any motor may be plugged in the ammeter circuit. I believe that both men and machines would be kept in better order if each machine had its own label, saying the amperes it should take, and the foreman occasionally plugged the machines on the ammeter. If he found that a machine which was rated to take 60 amperes was consistently taking 70, the conclusion he would draw would be either that the machine was out of order, the attendant was running too fast, or that some heavier cloth than was expected was going through.

We now come to the last consideration and the most important—the cost and efficiency of electric driving.

It cannot be denied that the cost is high. The figures I give here are figures based on actual work carried out, all of which has been put out to tender among the leading firms. I give the cost of so much per motor installed. It is made by selecting the cost of 20 different machines of the type most frequently met with in the trades I have mentioned. The horse-powers run from 3 to 20.

The first example is one in a works which was exceptionally wet and steamy, so that everything had to be absolutely water-tight.

Motors	£87	10	0
Switchpillars	10	0	0
Switchboard	16	0	0
Generator and engine	59	10	0
Gearing	34	0	0
Wiring	20	0	0
Erection	8	12	0
	£235	12	0

The next is an installation where it was not considered necessary that the motors should be watertight. They are enclosed to protect them from mechanical injury, but they are ventilated.

Motors	£69	0	0
Switchpillars	10	0	0
Switchboard	16	0	0
Generator and engine	59	10	0
Gearing	34	0	0
Wiring	20	0	0
Erection...	8	12	0
	£217	2	0

In the two cases I have kept the figures which are not affected by the moisture, &c., constant, although, of course, in actual practice, they varied somewhat. The item "Switchboard" may seem high, and probably might be reduced somewhat, but it does not include any luxuries.

In one particular case there is the main double-pole switch and fuse for the dynamo, a pair of bus bars, and a single-pole switch,

fuse, and the time fuse for each motor, two ammeters, and one voltmeter.

The item for wiring is heavy, but the works covered a large amount of ground. The use of bare conductors strained tight would reduce this if approved by the fire insurance companies. The cost of the engine and dynamo may be somewhat higher than necessary, as it is assumed that all the motors will be on at once and at full power. Sufficient experience has not yet been gained to ascertain what proportion of the maximum load on the engine will bear to the rated outputs of the motors installed. The cost of the gearing is accounted for in my remarks on the subject.

We may now assume that if a man has 20 engines in a bleach, dye, or finishing works which he wishes to replace with motors, it will cost him approximately £4,000; whereas the cost of 20 steam engines complete, with piping, &c., would be only about £2,000.

As a rule, we have to treat with works which already exist and are equipped with steam engines; we have therefore to show a saving on the entire capital outlay, viz., £4,000. The directions in which we may look for savings are:—

1. Decreased coal bill.
2. Decreased labour in stoking, &c.
3. Decreased labour in repairs, owing to steam joints blowing, glands leaking and requiring packing.

I do not propose to go into these items very carefully, as you, as a body of engineers, quite appreciate the losses. On the first item, which is after all the most important, from tests which were made by Mr. Bryan Donkin on 100 engines selected impartially, it was found that this type of engine was consuming on an average 150 lbs. of steam per H.P. per hour. We have seen that we propose to use an engine which will give us a B.H.P. hour for 20 lbs.

We may with safety put our losses between the brake H.P. delivered to the dynamo and the B.H.P. delivered to the machine to be driven at 20 per cent., which would be made up as follows:—

5 per cent. dynamo losses.
2 per cent. transmission losses.
5 per cent. motor losses.
8 per cent. gearing losses.

20 per cent. total losses.

If you only use half the coal, of course you only require half the stokers, and also half the number of boilers.

The maintenance costs have been certified by several owners, especially on the north-east coast, to be only 20 per cent. of their former maintenance costs when they used steam engines.

The amount saved by these items, of course, depends upon the size of the works and the amount used of each individual article.

There are certain works at present where it is somewhat difficult to see how electric driving can help them; it is those works which require all the exhaust steam which their engines can give them for boiling purposes. To such, economy of steam consumption is no temptation, as it practically costs them no more to raise their steam to 100 lbs. pressure than to raise it above the pressure of the atmosphere.

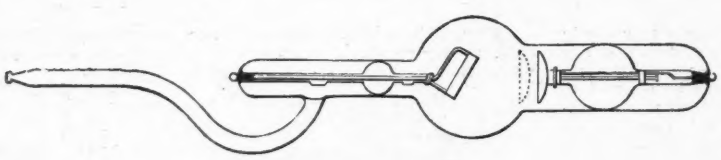
I have only been able in this paper to touch on a very few of the points which I have thought would interest members. The subject is a very fascinating one and is going to be in the future a very profitable one, because we are doing something more than saving coal; we are giving owners of works opportunities of carrying out their business on scientific lines, which, up to the present, has not been my experience.

AN IMPROVED ADJUSTABLE X RAY TUBE.

By A. A. C. SWINTON.

Further experiment has enabled the writer to design an improved form of adjustable X ray focus tube which has considerable advantages over the adjustable tubes he has previously described.*

The new tube is more easily and cheaply constructed than the multiple cathode tube previously illustrated, while it is also more quickly and readily adjusted. Further, it has a much greater range of



adjustment than the movable anti-cathode form of tube, and has the advantage that in adjusting it the position of the anti-cathode, and therefore the point of origin of the X rays is not interfered with.

As will be seen from the illustration, the essential feature of the new tube consists in mounting the cathode upon a steel rod sliding in two aluminium guides, supported in a glass tube, and connected by an aluminium wire to the cathode terminal. The arrangement is such that by using the tube in a horisontal position, and by simply tapping it at one end or the other, the cathode can be moved to a small extent in and out of a tubular neck, blown on one end of the glass bulb. In this way the position of the cathode can be altered without moving either the tube or the point of origin of the X rays on the anti-cathode. The exact position of the cathode relative to the glass walls of the tubular neck and bulb, is found to have an enormous effect upon the penetrative value of the X rays produced. With a suitable and constant degree of exhaustion, if the cathode is placed as shown in full lines in the illustration, X rays of very high penetrative value are produced, while the small movement of the cathode of about 0·3 inch towards the interior of the bulb required to place it in the position indicated by the dotted lines will suffice to reduce the penetrative value of the rays almost to zero.

Between these two extremes every grade of penetrative value is readily obtained by simply altering the position of the cathode between its limits of travel.

The effect is evidently due to changes in the electrical resistance of the tube, which, as measured by the alternative spark in air, is much highest when the cathode is in the position shown in full lines, *i.e.*, that which gives rays of the greatest penetration, and appears to be closely connected with the distance between the edge of the cathode and the glass which is least in the position just mentioned. This factor is evidently so important that it much more than neutralises the effect of the alteration to the distance between cathode and anti-cathode, which, as the writer has previously shown, has the result of increasing the penetrative value of the rays, and also the resistance of the tube the nearer these two electrodes are together.

In the tube illustrated the anti-cathode is made of a thick disc of aluminium faced with platinum, in the manner previously described by the writer. This arrangement is found to be very advantageous for tubes destined to be worked with considerable electrical power, say the full force of a 10-inch Rhumkorff coil.

Where smaller induction coils are employed, the ordinary form of anti-cathode may be used.

* Electrical Review, May 7th, page 630.

RAPID CABLE LAYING FOR WAR PURPOSES.*

By Lieut. CRUTCHLEY, R.N.R., and C. SCOTT SNELL.

(*Continued from page 726.*)

APPENDIX D.

The cutting of a cable which is being paid out at so rapid a rate as 30 feet per second presents certain difficulties and risks, unless it is done quite astern of all gear on deck, and also in a manner which does not entail either a sudden stoppage or a sudden release to mechanism working under stress.

This severance it is proposed to effect by the following means:—

The cable takes, say, two or more turns around the ejecting, motor-driven drum astern, and it is pressed upon just before leaving the drum by a wheel the same diameter as the drum; chain or other gearing joining them ensures synchronism in the movements of the two. In the periphery of one wheel is fitted a chisel, in that of the other an anvil. This is preferable to two chisels, as a small amount of back-lash in the gearing will not matter where a fairly broad anvil is used, whereas it would upset the meeting of two chisel points.

To these two accessories are fitted tail levers, which, being in different planes, do not meet as the wheels revolve, but if a blade (shown in the drawings and marked as a "parting lever") be dropped between these, each lever is forced inwards, the chisel and anvil protrude as the wheels turn, and the cable is severed.

It will be seen that short lengths would be continually cut off, like a string of sausages, unless the parting lever be at once removed. However, the cut being beyond the position where the cable is gripped, it does not affect the hold, or the load on the machinery generally. The paying-out mechanism may now be stopped as soon as expedient with safety; and here it must be noticed, that if the cable accumulator has been pretty well depleted prior to cutting the cable, it is possible to stop the stern ejecting drum very rapidly, and leave the accumulator to gather in the slack that obtains on account of the momentum of the main drum. With the small unit system the stoppage throughout may be much quicker.

The buoying arrangements shown in the drawings may be used, so that buoying may be also effected at full speed; or it is easy to let the cable ship pass between two other ships or buoys, connecting which a steel hawser is laid, with plenty of slack. It is thus easy to get hold of the cable without delaying the cable-ship.

The cable, it is assumed, would have a sinking rate of about 2 feet per second, and therefore a following ship in fleet evolutions would not foul it, refer to diagram, which also shows that a cable ship with a turning circle of 840 yards diameter would not cause inconvenience to the cable-laying.

If provision had to be made for harbour manœuvring it would be well to pass the cable over a pulley at the end of a long spanker-boom on the cable ship, so that it could be swung athwartships to clear the screws if the vessel had to go astern.

* Read before the Royal United Service Institution on Wednesday, April 28th, 1897. The illustrations are given by permission of the Council of the Institution.

APPENDIX E.

Inductive telegraphy is a special subject, about which much has been written, and which is still engaging a large amount of attention. With a view to ascertaining the views of two of the leading experimenters in this direction, the following problems have been submitted to them:—The diagram given below shows a land station, A, which is in communication with the cable vessel, B, 100 miles away,

Diagram 1.

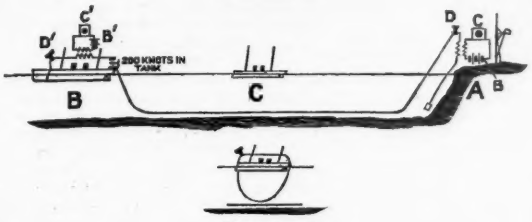


Diagram 2.

and which has still 200 miles of cable in her tank. A vedette, C, 50 miles out, wishes to communicate with either ship or shore, will there be any difficulty?

To this Mr. Charles A. Stevenson, of the Northern Lighthouse Board, replied:—"There is no difficulty in another cruiser or vedette communicating ashore, or to another cruiser that has laid down a

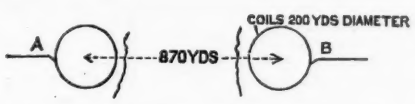


Diagram 3.

submarine cable from ashore at any part of the cable. All that is wanted is that the vedette have a bow connection with the water, and in addition a long tail wire reaching down into the water, working by electrostatic induction. I do not recommend telephonic communication for such a purpose. It is possible that a more effective arrangement would be attained by the electro-magnetic system, by looping the wire thus (see diagram 2), and this I am absolutely certain would work well, as I have tried it; but it is less simple of application in a nautical sense."

In *Engineering*, October 23rd, 1896, appears a letter from Mr. Stevenson, in which he says:—"Induction from a submarine cable, with currents of but a fraction of an ampere flowing in it, laid in 30 or 40 fathoms of water. . . . . is sufficient to make itself audible in a telephone aboard ship, in connection with a proper apparatus costing but a few pounds." Mr. Stevenson's experience in inductive methods of communication is too well known to need lengthy description. It is worth remembering in connection with this problem, however, that he succeeded in bridging a gap without wires, as shown in diagram 3. Current sent through A caused induced currents in B, thus maintaining communication.

The following problem was submitted to Prof. L. I. Blake:—

A, B, C, D, are enemy's ports, and cable is laid as dotted. Assume a vessel escapes from C heading towards B. The vessels at C are not swift enough to catch her, but if they can advise B she may be intercepted by more powerful vessels. Total length of cable from A to D is 250 miles, and we wish at each position to be able to communicate with the others. Prof. Blake replied:—"While the problem which you propose in regard to communicating between ports while under

Diagram 4.

blockade contains conditions not yet tried in full, still the experience which the Light-House Department of our Government (U.S.A.) here has had in the application of the method proposed by me, makes me feel confidence in accomplishing what you desire. I speak hesitatingly thus because I do not like to exceed my experience, but I am assured of the correctness of the principles involved.*

"The most difficult question in my mind would be the transmitting of sufficient energy in the form of an alternating current, through a cable of so much self-induction, if iron armoured, as a cable of this length would probably be.

"I found in practice that one terminal plate is sufficient on the ship, as the hull of a steel vessel or the metallic sheathing of a wooden vessel would serve well as the other plate."

Interesting Details of Sandy Hook Lightship.

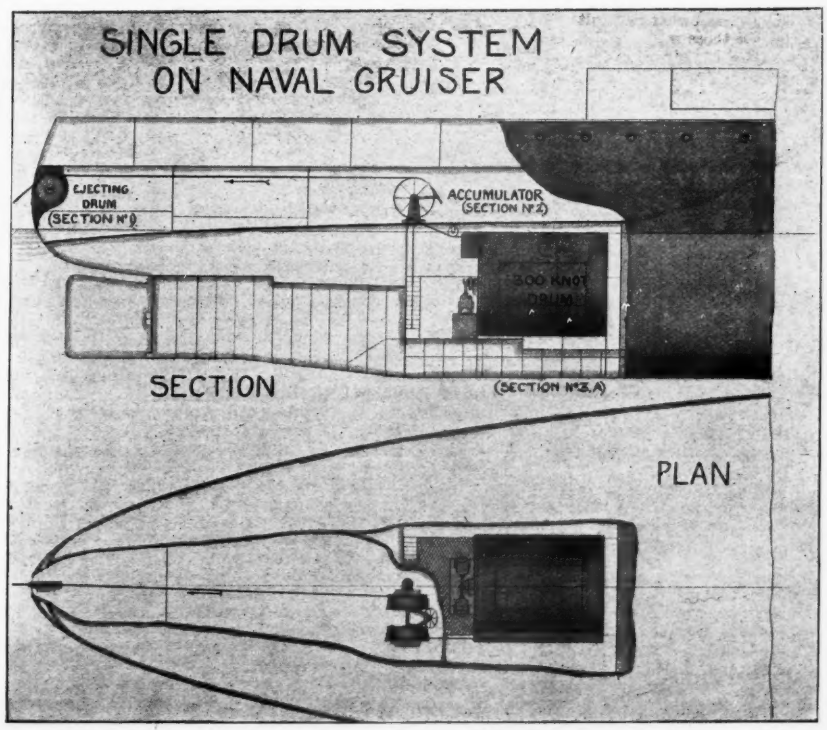
Prof. Blake adds:—"It is perhaps proper for me to state the experience which we have had in the application of the system off Sandy Hook, N.Y. We communicated telephonically there with a lightship lying six miles from the shore station, and our test plant was in operation some six months. The area of diffusion was about 16 acres, out of which the lightship could not swing. The energy delivered into the grid was exceedingly small, because it was necessarily limited by the power of the telephonic transmitter, and this power did not exceed 4 watts with the best transmitters that I could obtain anywhere or knew of. Had we attempted to telegraph by means of makes and breaks in the alternating current, receiving through a telephone, we could have delivered many fold the energy employed. Our purpose, however, was to allow *telephonic* communication by ordinary men handling the ship. While this is the limit of our practical experience, still, by means of an artificial cable, we seemed able to extend the length of the cable portion very many miles.

"I might add that within this area of diffusion we communicated constantly between moving vessels properly equipped, and could easily overhear conversation between the lightship and the shore station, while we were upon a neighbouring vessel. Of course, any such diffusion area could be secretly known and communication thus protected."

Notes on Prof. Blake's System of Communication.—A shore station, with B battery, C telephonic transmitter, D receiver, E earth plate. On the lightship S are similar appliances, similarly lettered, also G grid below, diagram 5. At Sandy Hook the depth of water is 10½ fathoms.

The equipment on the tender *Gardinia*, which steamed about and communicated, cost only a few pounds. In practice, the inventor has found that with a bare copper wire of low resistance (in place of the grid), he could develop the region of communication for about a mile or more along the direction of the wire, and for several hundred feet all around it. See Electrical Review, September 6th, 1895.

Other experimenters, amongst whom Messrs. Willoughby Smith and



* The technical details of the method of carrying out such an installation are also supplied by Prof. Blake; but as permission to make them public has not been obtained, they are reserved for the present.

Granville must be mentioned, have also investigated the subject, and sufficient experience seems to have been gained and *data* made available, to justify the assertion that simple strategic lines, from point to point, can be laid, that communication, along the length, by any vessel provided with a simple equipment costing but a few pounds, is a possibility, and, moreover, communicating vessels need not drop anchor or make any continuous metallic connection with the cable.

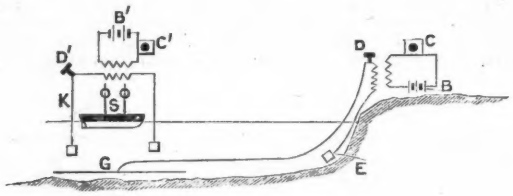


Diagram 5.

Such possibilities are interesting in peace time, but in war time may render invaluable aid and economise the labours of the vessels used for despatch services; above all, the convenience of instant and continuous communication is too apparent to need emphasising.

Diagram 6.

As an illustration of a method of communication so simple, it may be assumed that A is a port under blockade. D—E is a cable, and C is a blockading force always in touch with it, such as by a vedette boat or larger vessel cruising within its radius of induction. It is therefore plain that scouts, say, at D, upon sighting any hostile or relieving force attempting to raise the blockade, can fall back upon the immediate neighbourhood of the cable and inform the main body, C, without loss of time. By the cable, outlying scouts E, can be recalled to strengthen the main body. One or more cables may be used, or any different telegraphic arrangement made. In event of fog, the time saved and service rendered by the cable might be all-important.

The question of the efficiency and reliability of the systems above described does not materially affect the value of the power to lay a cable at 20 knots, as there is always the direct metallic connection system to fall back upon, and the possibility of a blockading force being able to establish an ordinary station upon an enemy's coast, where effectually covered by the guns of the squadron, or upon an outlying rock.

The following quotations from a leading article in the Electrical Review of April 9th, 1897, are worth attention. Under the title of "The Defence of the Empire," in reference to Lord Carnarvon's letter and speeches, this paper says:—"We think that the warning conveyed in his words to the House of Lords, in a speech made on April 14th, 1885, are worthy of repetition, and might with advantage have appeared amongst the selection. Space will not, however, allow of more than a short extract. In a discussion raised by a question drawing attention of Her Majesty's Government to the fact that the 'sole method of telegraphic communication with Hong Kong and some other British settlements in the East was by wires passing through a territory in the possession of a foreign power, and whether it was the intention of Her Majesty's Government to adopt immediate measures to insure the safety of intercourse by electric telegraph with those parts.' Lord Carnarvon said: 'The matter was a delicate one, but he thought it right to remind the House and the country that in 1878, when there were great alarms as to a Russian war, the Russian Government, who were perhaps more alive to the circumstances of the case than we were, had taken measures for cutting the submarine cables and for equipping ships for that special purpose. It was said at the time, and on good authority, and was generally believed, that there was a carefully elaborated scheme for taking measures against our submarine cables in the Eastern waters. It was quite right to mention these matters now, and he trusted that the Government had not been blind to the danger of leaving them unprovided for, but that while they had had the opportunity and a full warning, they had taken those steps and those measures which might be necessary at any hour.'

"The political outlook to-day is similar in many respects to that existing at the time referred to in the above remarks, and yet we are little, if indeed at all, nearer to a position of safety as regards telegraph communication than we were then. Under such conditions it was, to say the least, disquieting, to know that the only two direct cables between Malta and Alexandria were simultaneously interrupted a fortnight ago, the Eastern Telegraph Company announcing that telegrams for Egypt by their cables suffered delay; and communication was not restored for about a week. In a time of international complications such as the present, it is not at all reassuring to call to mind that in the event of the two cables between India and Egypt being interrupted, our only reliance for news to or from India, China, and Australia, must be placed on land-lines, one of which passes through Persia and Turkey, &c., and the other across Siberia and Russia. In reference to one of these routes we may, perhaps, be allowed to quote from a note which appeared some time ago in these columns. 'The Russian Telegraphic Administration has informed the directors of the Indo-European Telegraph Company, Limited, that the latter will not in future be permitted to fill up vacancies which occur in the company's Russian stations with English operators; telegraphists from the Russian service are to be recruited for this purpose.'

"With such knowledge available, it is astonishing that no effective means have as yet been taken to place beyond danger our means of assured telegraph communication between England and her Eastern and Australasian possessions."

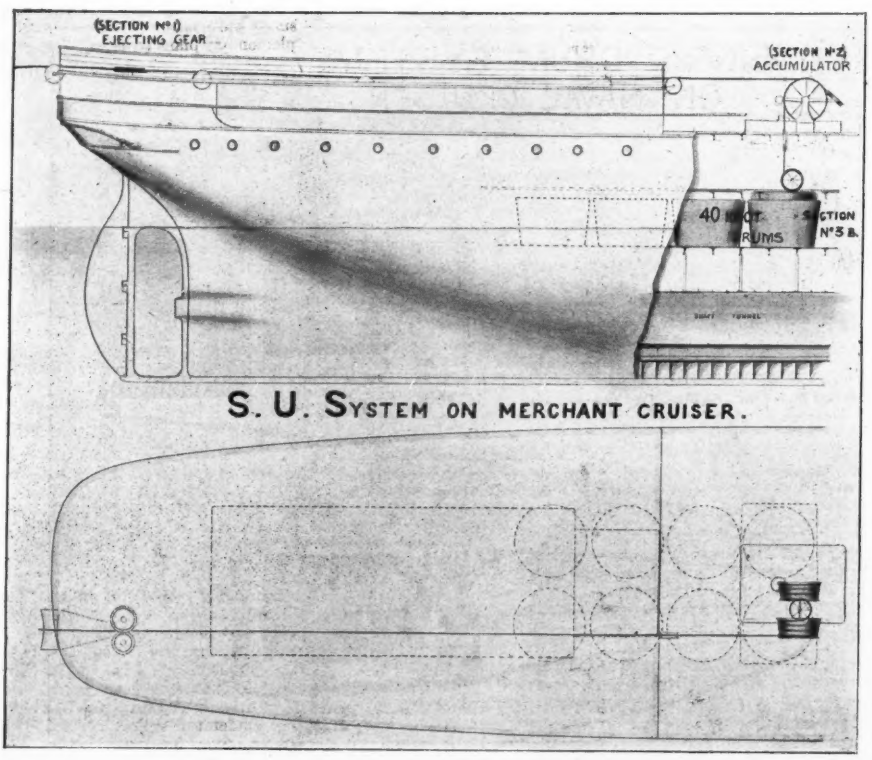
APPENDIX F.

Wire Rope Installations—to Show Speed of Delivery.

On the Schauffhausen system the pulleys are placed from 330 feet to 450 feet apart, whilst the speed of the ropes is 61·8 feet per second. This is 36½ knots per hour.

The speeds at which wire ropes are commonly driven range between 30 feet and 80 feet per second, and 80 feet per second is 63 knots per hour.

As regards vertical winding in collieries:—In the case of Walsall Wood Pit, No. 1, the maximum speed is reached in 18 seconds, the time occupied in taking the run of 550 yards is 44 seconds, which gives an average speed throughout the run of 37½ feet per second, the maximum speed being 60 feet per second, or over 40 miles per hour. Dead load at moment of starting 142 cwts.



S. U. System on Merchant Cruiser.

There is little question that the rapid manipulation of the load and accurate stopping required in colliery operations involves careful attention, yet it is successfully effected year in and year out. When therefore we consider that the problem of high speed cable laying requires no such sudden or extreme variations in speed, but consists essentially of throwing away the cable at a steady speed, a little in excess of that of the vessel, we surely need not despair of success. Further, we have our 2,000 feet of cable in hand as a stand-by for emergencies.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Discussion on Mr. Raworth's Paper.

Mr. Geipel considered the lower efficiency of a steam engine at light load was better expressed by the loss of steam per unit, than by the increased consumption of steam per unit. The maximum economy ought to be at $\frac{3}{4}$ or $\frac{2}{3}$ load and not at full load. He agreed with Mr. Raworth in condemning small units, chiefly on account of the increased radiation from the numerous pipes. The size of units, in recent specifications, has been on the increase. For tramway work he thought 2 units best. The single unit recommended by Mr. Raworth, made it difficult to provide for increase of traffic due to increased population. He thought that in combined stations, there would be a greater saving on the attendance and depreciation that Mr. Raworth had estimated.

Mr. Tremlett Carter showed some interesting tables to illustrate the difference in cost of a unit generated for electric traction, and a unit for electric lighting. In the first three cases in Table I. the items had been taken from official returns, and in the last two cases the figures were Raworth's ideal for traction and Crompton's for lighting. Table II. was made up from figures he had just received from America.

Table I.—Generating Expenses of Steam Driven Electric Power Stations.

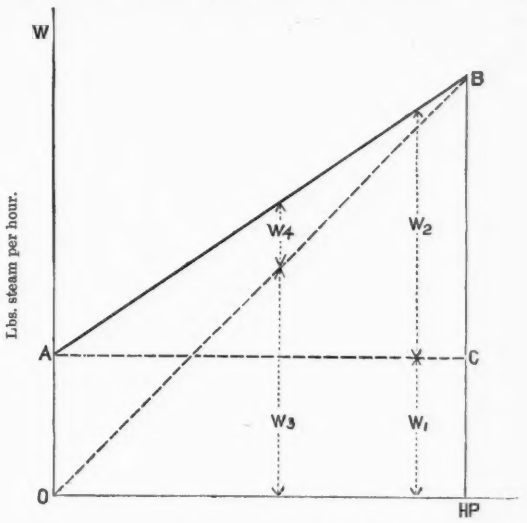
Item.	Liverpool Overhead Railway.		Metropolitan Railroad of Washington.	Manchester Electric Supply.	Raworth ideal.	Crompton ideal.
Period of working ..	Jan.-June, 1896.	July-Dec. 1896.	Sept., '96. Feb., '97.	April, '95. Mar., '96.	Twelve months.	Twelve months.
Train mileage	313,010	320,993	—	—	—	—
Units generated ..	1,343,129	1,377,060	2,835,520	1,926,000	1,000,000	5,000,000
	Pence per unit generated.					
Coal	0·118	0·121	0·225	0·380	0·196	0·270
Oil and stores	0·038	0·062	0·046	0·138	0·013	0·030
Wages and salaries ..	0·460	0·459	0·198	0·418	0·198	0·620
Repairs and renewals	0·174	0·215	—	0·132	0·234	0·400
Total	0·790	0·857	—	1·068	0·641	1·320

Table II.—Pence per Unit Generated.

Item.	Chicago City Railway.		Metropolitan west side elevated of Chicago.
	Station 1.	Station 2.	
Fuel	0·244	0·183	0·167
Labour, &c.	0·109	0·037	0·107
Stores, &c.	0·024	0·019	0·025
Repairs, &c.	0·001	0·002	0·015
Interest and depreciation	0·165	0·078	0·200
Total	0·544	0·319	0·514
Cost of station	£77,000	£80,000	£127,500
Capacity, kilowatts	5,250	5,280	4,500
Units generated per month	1,067,200	2,375,000	1,460,000

These figures showed conclusively that power could be generated at a very much lower cost for electric traction, with a very high load factor, than in electric light stations where the load factor was microscopic. Mr. Carter objected to Mr. Raworth's diagram, because it did not represent correctly the real physical facts of the case. For example, the ordinates of the line, A B (fig. 1c), ought not, he said, to be divided by a line O B (Raworth), but by a line A C. There was no consumption of steam which was a maximum at no load, and decreased continuously to zero at full load, as represented by Mr. Raworth's diagram. This point was brought out still stronger by fig. 2c, in which a line, A_2, B_2, representing the brake H.P. was drawn parallel to A_1, B_1, representing the I.H.P. The interpretation of the Raworth lines, O B_2, O B_1, led to such irrational conclusions as that the steady friction did not require a constant loss of steam to overcome it, but actually increased the amount of steam usefully consumed as represented by the interval between O B and the horizontal axis. Mr. Carter considered that the superiority of cut-off governed engines over throttle governed engines for electric traction was due to the fact that the former had a greater reserve of power. He showed by a diagram that the minimum consumption of steam in a cut-off governed engine was a function of the speed and the H.P. developed, and suggested that slow variations of load might be economically dealt with by varying the speed of the engine. He considered three units preferable to two units in a station, because there was in the former case less idle plant. The diagram, fig. 3c, was exhibited by Mr. Carter to show the very considerable diurnal variations of load that occur in a traction station. It is taken from the Philadelphia traction power station and is typical.

Professor Perry asked if governing by both throttle and cut off had ever been tried? He considered that it would have some advantages.



$W = W_4 + W_3 = W_1 + \omega$ H.P. Willans.)

$W = W_3 + W_4 = \alpha$ H.P. $+ \beta\left(1 - \frac{P}{100}\right)$ (Raworth.)

Fig. 1c.

Mr. Crompton said it had been tried on the Willans engines. He did not have great faith in governing by cut off; it had been frequently tried before and given up again in favour of throttle governing. Cut off governing brings a greater strain on the cylinder, and increases the initial condensation, and the cut off gear deteriorates rapidly as the engine wears out.

Mr. Macmahon of the South London Electric Railway, objected to single unit stations. He preferred one large unit and a small supplementary plant to supply extra requirements.

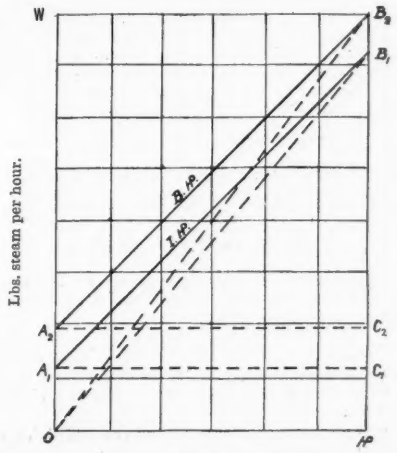


Fig. 2c.

Mr. Grove said that at the Shoreditch dust destructor station, where the boiler pressure underwent considerable variation, the engineers had adopted the double system of governing.

Mr. Gadsby considered that two units were not so good as three. Two plants might be used in parallel for heavy load. He condemned the combination of traction and lighting work on account of the large number of short circuits which occur in traction work; and he also condemned the variation of speed recommended by Mr. Tremlett Carter, since the power gained would be lost in the resistances. Double governing was too complicated to make the game worth the candle.

Mr. Garcke expressed surprise at the prices asked by central stations in this country, for power supplied for electric traction. In his experience as much as 4d. per unit had been asked for. It was a serious mistake to imagine that the price charged for traction should be the same as for lighting. From the commercial point of view, he thought the combination of the two kinds of supply ought to be profitable.

Mr. Wordingham said he spoke as a municipal engineer. In Manchester they supplied the unit at 1½d. when large quantities were taken for long hours.

Mr. Clirehugh said Ashton-under-Lyne was putting down a station

which would combine traction and lighting. He thought the H.P. was preferable to the B.O.T. unit for traction work. He thought a great saving could be effected by the judicious use of accumulators. He disagreed *in toto* with Mr. Gadsby, and considered that lighting and traction plant could be run off the same engine. The dynamos made in America were not suitable for traction, but those made in England were suitable for both.

Mr. Sydney Morse quoted some interesting statistics from municipal reports, giving the price of the unit for traction at several

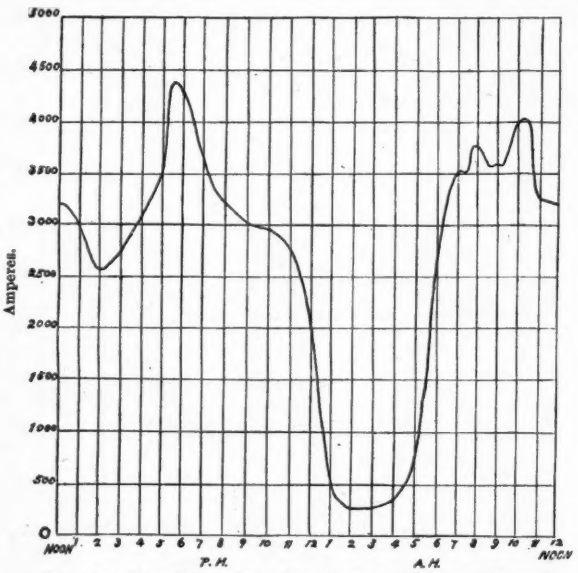


Fig. 3c.—Load Diagram of Philadelphia Traction Power Station.

places on the Continent. At Hamburg the unit cost 1d., coal being at 18s. a ton; at Berlin, 1d.; at Dresden, 1½d.; at Liege, 1d.

Mr. Raworth in reply to Mr. Tremlett Carter, said that the difference between them was merely a question of definition. Double governing had been employed as the outcome of a paper read by Capt. Sankey, but he did not know what had been the practical result. The shaft governor gave the same effect without any extra mechanism. He had always understood that the reason why the cut off governor had not been applied to the Willans engine, was because Mr. Willans did not know how to do it. In cotton mill engines power was produced at ¼d. per unit on account of the very favourable conditions.

The President said that at Oxford they were now proposing to put down a very large unit, but he should not care to rely on that alone. Unfortunately for the combination of traction and lighting, the peaks of the two diagrams were liable to coincide.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

11,558. "Improvements in electrical gas lighting apparatus." J. F. Bennett and R. H. Marples. Dated May 10th.

11,575. "Syntonised telegraphy without line wires." O. J. Lodge. Dated May 10th.

11,578. "Improvements in or relating to carbon plates, rods or the like for galvanic batteries." F. J. Gillibrand. Dated May 10th.

11,594. "Application of electricity to the working of artillery and for other purposes." G. Martinez. Dated May 10th.

11,603. "An improvement in plates for secondary voltaic batteries." E. Riley. Dated May 10th.

11,622. "Improvements in apparatus relating to the distribution and use of alternating or pulsating currents of electricity." R. E. B. Crompton and W. A. Chamen. Dated May 10th.

11,626. "Improvements in regulating or governing electric generating plant." E. F. Carter. Dated May 10th.

11,684. "Improvements in electrical radiators and water boilers for cooking and heating purposes." J. Chambers. (Date applied for under Patents, &c., Act, 1883, Section 103, 12th October, 1896, being date of application in New Zealand.) Dated May 11th.

11,685. "Apparatus for recording the time occupied in telephonic conversations." E. Bödeg. Dated May 11th.

11,701. "Improvements in the construction of dynamo-electric machinery." A. Soames. Dated May 11th.

11,702. "Improvements in electric cables." T. Petersen. Dated May 11th.

11,714. "An improvement in holders for electric glow lamps." H. C. Gover and C. F. Proctor. Dated May 11th. (*Complete.*)

11,716. "Improvements in the electric laying of cannon or torpedo tubes." J. Eastwick and I. A. Timmis. Dated May 11th.

11,717. "Improvements in devices for enabling railway travellers to apply the brakes by electrical means." F. J. Preston and A. B. Gill. Dated May 11th.

11,741. "Improvements in electric arc lamps." E. Webber. Dated May 11th.

11,760. "An electric disinfector." H. Kimber. Dated May 12th.

11,787. "Improvements in metal rails, fixtures and fittings for railway roads, tram roads, and electric and other railways." W. B. Berrey and J. S. Warburton. Dated May 12th.

11,800. "Improvements in and connected with the formation of galvanic batteries." S. de la Precilla. Dated May 12th.

11,808. "Improvements in incandescent electric lamps." A. Woodley. Dated May 12th.

11,844. "Improvements in voltaic batteries and electrolytic decomposition cells." G. C. Allingham and W. Fennell. Dated May 12th.

11,846. "Improvements relating to electric lamps for cycles." T. G. Howden. Dated May 12th.

11,861. "Improvements in or relating to electric accumulators or storage batteries." O. Lindner. Dated May 13th.

11,891. "Improvements in apparatus for making or breaking an electric circuit at the end of a prescribed period of time." J. Davidson. Dated May 13th.

11,919. "Improvements in preparing, preserving covers or coating for telegraph pillar walls, tablets, and wood in general." J. Kopelowitz and J. M. Kopelowitz. Dated May 13th.

11,945. "An improved arrangement for reducing the apparent resistance in telephone conductors." E. von Szvetics. Dated May 13th. (*Complete.*)

11,962. "Improvements in means for electro-plating articles of wood, papier-maché, bone, and other materials not adapted for direct electro-deposition." L. Forsdike. Dated May 14th.

12,019. "An improved apparatus for maintaining a constant temperature of metallic wires heated by an electric current." R. Bergland and Baron R. de Wendel. Dated May 14th. (*Complete.*)

12,028. "Sulphuring carbon plates for galvanic batteries." R. W. Atkinson and S. F. Walker. Dated May 15th.

12,063. "Improvements in electricity meters." G. Hookham. Dated May 15th.

12,068. "An improved incandescent electric lamp." J. W. Hebb. Dated May 15th.

12,073. "Improvements in secondary battery plates and in moulds for making them." H. W. Headland and Headland's Patent Electric Storage Battery Co., Ltd. Dated May 15th.

12,087. "Switch apparatus for the graduated inclusion and exclusion of resistances in electrical circuits." Siemens Bros. & Co., Ltd. (Siemens & Halske, Germany.) Dated May 15th.

12,088. "Improvements in apparatus for controlling electric motors." Siemens Bros. & Co., Ltd., and A. J. Stopher. Dated May 15th.

12,089. "Apparatus for controlling electric motor generators at a distance." Siemens Bros. & Co., Ltd., and P. T. J. Estler. Dated May 15th.

12,090. "A self-locking electrical signalling instrument." Siemens Bros. & Co., Ltd., and G. Forrest. Dated May 15th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free*, 8½*d.* (*in stamps*).]

1896.

2,224. "Improvements in prepayment mechanism for electrical or other meters." C. O. Bastian and H. C. Hodges. Dated January 30th, 1896. Relates to meter mechanism of coin feed apparatus adapted on the insertion of a coin to separate the parts of a contact making device a given distance from one another in a local electrical circuit, and simultaneously open the supply through the meter. When the predetermined amount of electricity has been supplied, the current is cut off until the insertion of another coin. 4 claims.

2,324. "An improved electric coupling." J. H. Tucker. Dated February 1st, 1896. The invention relates to electric couplings commonly known as wall plugs and sockets, and the object of the invention is to prevent the safety fuse when fired under an excess of current from falling across the two poles of the coupling and thus causing a short circuit. By making one of the tubular contacts as a bridge which divides the inner space enclosed by the cover and the base into two compartments and so separate the two poles of the coupling as to prevent any part of the melted fuse from causing a short circuit. 4 claims.

2,335. "Improvements applicable to electric meters." W. McWirter. Dated February 1st. Relates to an improved bobbin for electric meters constructed with soft iron flanges, the bobbins being in whole or in part surrounded by a shield or casing of soft iron. The application of the soft iron in this way has several advantages. It increases the magnetic field at the end of the core so as to allow the meter to be actuated by comparatively small power. It screens the movement from the action of external magnetic fields such as exist in the neighbourhood of dynamos, &c. 1 claim.

28,761. "An improved electrical brake for vehicles." E. Grosz. Dated December 15th, 1896. Relates to an electrical brake for railways or non-automotive carriages. The invention consists of electro-magnetic coils, which, when a current is passed through them, suck in an iron core which actuate levers and put on the brake. 3 claims